FIELDWORK, GEOLOGY, AND EARLY COMPONENT RESEARCH DURING 2001–2002 AT THE BARNES SITE, 5LA9187, PINON CANYON MANEUVER SITE, COLORADO

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14. ABSTRACT
An archaeological field program consisting of geologic investigations, intensive surface collection, and hand excavations occurred during the period July 15 through August 24, 2001 at the Barnes site, 5LA9187 on the Pinon Canyon Maneuver Site, Colorado. Geologic studies centered on exposure and documentation of ca. 131 m of backhoe trenches that revealed a complex geomorphic history that included numerous scour, aggradation, and lateral truncation cycles during the early/middle Holocene. Radiocarbon dates indicate that all tested sediments are ca. 7600 BP or younger in age. Test excavations occurred in dispersed shallow and deep units that covered all or parts of 35 one-meter squares and removed and processed ca. 22.4 cubic meters of site fill. The Late Prehistoric is highly significant, producing more than 700 artifacts in the surface collection, three hearths, and and unusual pit feature that contained more than 1,400 small stone beads. The Late Prehistoric component warrants detailed study and interpretation as well as site preservation, if at all feasible.

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ABSTRACT

An archaeological field program consisting of geologic investigations, intensive surface collection, and hand excavations occurred during the period July 15 to August 24, 2001 at the Barnes site, 5LA9187, on the Pinon Canyon Maneuver Site, Colorado. This study was sparked by discovery in 2000 of a Folsom point, other possible Paleoindian artifacts, and an extensive Late Prehistoric age artifact scatter that was being impacted by erosion and military maneuver activities. Field investigations and much of the analytic effort to date have focused on possible early and buried components at the site. Geologic studies centered on exposure and documentation of ca. 131 m of backhoe trenches that revealed a complex geomorphic history that included numerous scour, aggradation, and lateral truncation cycles during the early/middle Holocene. Radiocarbon dates indicate that all tested sediments are ca. 7600 BP or younger in age. Test excavations occurred in dispersed shallow and deep units that covered all or parts of 35 one-meter squares and removed and processed ca. 22.4 m^3 of site fill. These tests sampled the Late Prehistoric component and associated features in several areas, but failed to discover significant buried components. One Plains Archaic hearth dating to 6800-7000 BP was excavated. Artifact studies indicate that the Folsom point is the only Paleoindian specimen in the sample and that it is geologically out of context. Despite the results of this particular effort, the potential remains high for productive study of significant Paleoindian components on the PCMS. The Late Prehistoric component is highly significant, producing more than 700 artifacts in the surface collection, three hearths, and an unusual pit feature that contained more than 1,400 small stone beads. The near-surface excavated collection contains an additional 700 specimens that include chipped stone tools, flakes, pottery, and a few other artifact classes. Initial studies of artifact provenance indicate the presence of many raw materials from distance source locations, suggesting high mobility and a complex sphere of cultural interaction for the people who occupied the Barnes site. The Late Prehistoric component warrants detailed study and interpretation as well as site preservation, if at all feasible.

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ACKNOWLEDGEMENTS

A large number of individuals participated in and contributed in many ways to the success of the field program. Randy Korgel and Larry Loendorf maintained a high level of priority for fieldwork at 5LA9187 among the diverse programs that were ongoing simultaneously on the PCMS; this level of support was critical to project success. Randy arranged a helicopter for aerial photography, supported many aspects of project logistics, and oversaw site backfilling, and we are especially thankful for these efforts. We thank Steve De Vore for providing total station equipment, taking the lead in surface mapping, and for sharing the results of his study of magnetic susceptibility for Barnes site sediments. Mark Owens did a masterful job of balancing crew assignments and seeing that our personnel needs were always met. We thank Mark and Bonnie Newman for procuring critical artifact collections from previous studies, and Mark for showing us additional sites where Folsom specimens have been found. We especially thank Sherry Landis for the hearty, tasty, plentiful, and punctual meals and for her memorable accomplishments in the challenging role of camp commandant. We thank Pamela Cowen and Minette Church for the loan of field equipment and for flexibility in sharing their historic site testing crew. We are thankful to many persons who participated in arduous fieldwork as paid and volunteer crew members. From NMSU these include: Nancie Lee Albin, Kelli Barnes, Joseph Bergstrom, Keith Hahn, Roche Lindsey, and Ardeth Vineyard; from UCCS: Kimberly Henderson, Cheryl Wagner, John Gust, Jonathan Sanchez, and Kay Manke; from MWAC: Michael Chidley and Kevin Baldwin; from DECAM: Cody Anderson and Thad Swan; from PCRG: Jerry Morrow, Don Owens, Robert M. Gardner, Cherie Freeman, and Mark Mitchell; independent volunteers include stalwarts Jennifer Hudson and Caralee Maechtle and walk-on visitor David Parrish.

The lab work and reporting program also involved contributions from many individuals not named as authors on the report, and for which the editor is particularly thankful. Herbert Haas of RC Consultants of Las Vegas, NV, conducted meticulous preparation and pretreatment of AMS samples dated in the study with his usual degree of full communication and attention to detail. Herbert also expedited delivery of the samples to Europe and production of dating results. Mark Owens, Steven De Vore, and Kelly Wright of DECAM provided the total station data set in Surfer format that was used to generate the contour map in the report. Roche Lindsey and Jack Hofman provided copies of all of their digital photography taken during the field program. Larry Loendorf supported additional funding applied to lab studies of soil and sediment samples and processing of excavated samples from the Late Prehistoric component. The report is greatly enhanced by knowledge about the general content and distribution of late component artifacts. Carl Falk of Sevierville, TN and, through Carl, Richard Jantz of the University of Tennessee-Knoxville kindly examined on short notice and in detail several problematic burned bone specimens from the site. Bruce Ahler took time from this schedule to examine in detail and provide mineral identifications and other information for several stone artifacts made from non-local materials. Phil Geib examined several artifacts from the site and shared much information about Southwestern stone bead production and Navajo seed bead production. Lab assistants Vincent Warner, Jennifer Chumbley, and Ryan Corkill floated, sorted, and quantified the excavated samples reported here. Valor Holton and Chad Badorek conducted data entry and data error checks. Everett Fuller prepared digital versions of the line drawings and the photograph of the Folsom point that appear in the report. I am thankful to each of these individuals, whose diverse contributions have made this a better product.

FOREWORD

The archeological investigations reported in this manuscript are an important part of the Fort Carson Cultural Resources Management Program whose goal is to maintain the largest possible area for military training while protecting significant cultural and environmental resources. The current study is part of an integrated plan that takes a long-term systematic approach to meeting identification, evaluation, and resource protection requirements mandated by the National Historic Preservation Act. While meeting legislated requirements, this project also provides a valuable contribution to our knowledge of the prehistory and resources of Las Animas County, Colorado. Under a cooperative agreement, PaleoCultural Research Group with New Mexico State University operating through the National Park Service, Midwest Archeological Center, provides assistance in meeting Fort Carson's cultural resource goals.

Fort Carson began cultural resource studies on the Pinon Canyon Maneuver Site in 1983, immediately following the purchase of these lands. The Cultural Resource Program takes a multidisciplinary approach, combining archeological theory and historical methods with geological, geomorphological, botanical, and statistical techniques and procedures in order to focus its efforts to locate, evaluate, and protect significant cultural resources. Professional studies and consultations with Native American tribes have resulted in the identification of National Register of Historic Places eligible sites and districts. The cultural resources of Fort Carson and the Pinon Canyon Maneuver Site represent all major prehistoric and historic cultural periods recognized in the Great Plains and Rocky Mountains. Sites of the Paleoindian, Archaic, and Ceramic stages are present as are sites from the Fur Trade era, 19th century Hispanic and Euroamerican settlements, early 20th century homesteading and ranching, and World War II and Cold War era military sites.

The Cultural Resources Management Program is in the Directorate of Environmental Compliance and Management (DECAM). The directorate is tasked with maintaining Fort Carson's compliance with federal, state, and local environmental laws and mandates. The DECAM holistic management philosophy holds that all resources are interrelated. Decisions affecting one resource will impact other resources. The decisions we make today will affect the condition of Department of Army lands and resources for future training, research, and recreation. Mission requirements, training resources, wildlife, range, soil, hydrology, air, and recreation influence cultural resources management decisions. Integrating compliance and resource protection concerns into a comprehensive planning process reduces the time and effort expended on the compliance process, minimizes conflicts between resource protection and use, allows flexibility in project design, minimizes costs, and maximizes resource protection.

Federal laws protect the resources on the Pinon Canyon Maneuver Site and Fort Carson. Theft and vandalism are federal crimes. Protective measures ensure that Army activity does not inadvertently impact significant cultural and paleontological sites. Fort Carson does not give out site location information nor are sites developed for public visitation. Similar resources are located in the Picketwire Canyonlands where public visits can be arranged through the U.S. Forest Service, Comanche National Grasslands in La Junta, Colorado.

Fort Carson endeavors to make results of the resource investigations available to the public and scientific communities. Technical reports on cultural resources are on file at the Fort Carson

Curation Facility (Building 2420) and the Colorado State Historic Preservation Office. They are also available through the National Technical Information Service, Springfield VA. Selected reports have been distributed to public libraries in Colorado. Three video programs produced by Fort Carson are periodically shown on Public Broadcasting Stations. Non-technical reports on the prehistory, history, and rock art of southeastern Colorado have been distributed to schools and libraries within the state. Fort Carson continues to demonstrate that military training and resource protection are mutually compatible goals.

Thomas L. Warren
Director
Directorate of Environmental Compliance and Management
Fort Carson, Colorado
May 2002

1. INTRODUCTION

Stanley A. Ahler

Background and Overall Project Goals

During July 2000 site 5LA9187 was discovered and documented by New Mexico State University (NMSU) survey crews working on the Pinon Canyon Maneuver Site in southeastern Colorado. The site was found to contain an extensive and potentially very significant Late Prehistoric age component at the surface dominated by projectile points, other stone tools, and pottery. The surface collection also contained two fragments of a single Folsom projectile point (surveyor Kelli Barnes recognized one of these as a fluted point) as well as end scrapers, bifaces, and other artifacts considered by survey staff as likely to be Paleoindian in age. Limited backhoe trenching and geological investigation were conducted during September 2000 in an attempt to verify the presence of one or more buried Paleoindian components. That trenching and geological work has not been formally reported, but aspects of those investigations are treated here. A geophysical survey was conducted over part of the site during this work effort, and this work has recently been reported (De Vore 2001; Appendix A, herein). Two unpatterned chipped stone artifacts and three possible fire-cracked rock pieces were recovered in one of the backhoe trenches at a depth of ca. 90 below surface, on or just below the surface of a dark sediment unit that was interpreted at the time to be the A horizon of a buried soil. These artifacts were considered to provide supporting evidence for the presence of at least one deeply buried component at the site. An attempt to radiocarbon date sediments just above this paleosol yielded results so old (roughly 18,000 BP) it was considered to reflect contamination, probably by organic material from shales in the local bedrock. All of the above information formed the background for the field investigations at the Barnes site in 2001.

Additional fieldwork was conducted at the Barnes site, 5LA9187, from July 15 through August 24, 2001. The 2001 field program is the basis for this report. This fieldwork was integrated with a larger-scale field program being conducted by NMSU for the U. S. Department of the Army (Directorate of Environmental Compliance and Management; DECAM) through a cooperative agreement between NMSU and the U. S. National Park Service, Midwest Archeological Center (MWAC). This larger program involved an extensive archaeological survey and historic site testing program (the latter conducted through the University of Colorado at Colorado Springs; UCCS) as well as fieldwork at site 5LA9187. The fieldwork at the Barnes site was conducted through a contractual agreement between PaleoCultural Research Group (PCRG) and NMSU. Under this agreement, the role of PCRG is 1) to provide overall supervision and direction of fieldwork and to conduct additional geological field investigations, with field workers drawn from a combination of paid and volunteer personnel associated with NMSU, DECAM, MWAC, UCCS, and PCRG; and 2) to take the lead in analyzing and reporting on geological studies, all artifacts and materials recovered in contexts predating the near-surface Late Prehistoric age component, and all recovered Paleoindian age artifacts from the site (in surface or subsurface contexts). This agreement was amended to include additional fieldwork by the project geologist; certain laboratory studies of soils and sediment samples considered to be important for interpretation of the geoarchaeology of the site; and the processing, sorting, and basic quantification of all artifacts and other materials excavated from stratigraphically higher,

Late Prehistoric age contexts. Detailed analysis and reporting of the Late Prehistoric age artifacts are not to be conducted by PCRG under the amended agreement, but will be completed through processes outside this agreement and report.

Scheduling, Workflow, and Personnel

During the course of fieldwork, supervisory staff consisted of Stanley A. Ahler (Field Director), Jack L. Hofman (Assistant Field Director), David Kuehn (Project Geologist), and Mark Owens (Assistant Field Supervisor). Fieldwork was conducted during part of one (July 15-19) and all of two other (July 25-August 2 and August 8-16) nine-day work sessions. A brief episode of close-out work involving archaeomagnetic sampling of a deep hearth (Feature 10) was conducted by Dr. Jeffrey Eighmy, Colorado State University, on August 23 with assistance from DECAM personnel, and the site was backfilled by DECAM personnel on August 23-24, 2001. Ahler was on-site in the periods 7/15-19, 7/25-30, and 8/11-16. Hofman was on-site during both full 9-day sessions, 7/25-8/2 and 8/8-16, and directed the project in Ahler's absence. Kuehn was on-site at the start of the project, 7/15-21, and at the end of the project, 8/14-16. Owens on on-site or in the project area during all work periods. Steven De Vore of MWAC took part in the field program for several days after the start of fieldwork during July and near the end of fieldwork during August. Steve assisted in equipment procurement and used MWAC total station equipment to record excavation unit and trench locations, surface artifact locations, and additional topographic map data. Various combinations of crewmembers from the sources noted above took part in the field program. The total crew size averaged about 6 per day during backhoe trenching and surface work during July (about 30-persons-days of total effort occurred during this part-session). Total crew size varied from ca. 13 to 18 persons and averaged between 14 and 15 persons per day during each full nine-day session. Nearly all of the effort during this period was devoted to hand excavation and related sample dryscreening and waterscreening tasks. An estimated 125.5 and 124 person-days of effort occurred during each respective full 9-day session. The results of field investigations have been summarized in a report generated in September 2001 by the main PCRG participants (Ahler et al. 2001). Portions of that report are used herein, with appropriate additions of new information gained through several kinds of additional research.

During fieldwork an unusual and significant archaeological feature was discovered (Feature 5), which was a Late Prehistoric age pit that contained numerous very small stone beads. One crewmember, Roche Lindsey, worked throughout the field program on excavation and detailed documentation of this pit and its contents. Before the close of fieldwork Larry Loendorf of NMSU made the decision that all of the excavated contents of this pit and the surrounding excavation squares would be segregated from the balance of the excavated materials and would be studied by Roche Lindsey. This separation of excavated materials was done at that time. The remainder of the excavated samples and materials from all other contexts (surface, shallow, and deep) was transported from the field to the PCRG lab in Flagstaff, Arizona. As noted above, work in Flagstaff focused on analysis and reporting of early artifacts and all samples from deep (potentially old) contexts, but the work agreement was eventually modified to include processing, sorting, and quantification of Late Prehistoric context samples then in Flagstaff (exclusive of materials under study elsewhere by Roche Lindsey).

Work in Flagstaff progressed as planned. When the project proposal was developed in the spring of 2001, it was intended that lab work as well as fieldwork would be conducted under the co-direction of both Ahler, the principal investigator, as well as an unnamed MA level archaeologist on the PCRG staff. The latter archaeologist was added to the PCRG staff only near the very end of the project. Dr. Jack Hoffman of the University of Kansas ably served as co-director during fieldwork. Most lab work and report preparation have been conducted in Flagstaff under Ahler's direction with assistance from several laboratory and technical personnel. George Crawford assisted in editing and formatting the revised final report and conducted final report production. Dr. David D. Kuehn has been in charge of all soils, stratigraphic, and geological studies, with his work focusing primarily of field investigations of several backhoe trenches and lab studies of sediment samples. Ahler and Kuehn have interacted very closely in development of Kuehn's section of this report. Ahler coordinated the selection and submittal of samples for radiocarbon dating, mostly from geologic rather than archaeological contexts, and all graphics used in Kuehn's section of the report were prepared in the Flagstaff lab. One radiocarbon sample for the project was dated by Beta Analytic, and its submittal was handled by Steve De Vore of MWAC. Dr. Herbert Haas of RC Consultants, Inc., Las Vegas Nevada conducted pretreatment of the remaining AMS radiocarbon samples reported here as well as coordination with the AMS dating facility (ETH-Hoenggerberg in Zurich, Switzerland). Dave Kuehn coordinated special studies of sediment and soils samples reported here. Stable carbon isotope analysis was conducted at Geochron Laboratories, Cambridge, Massachusetts, and analysis of soil organic and inorganic carbon was performed at the Texas A&M Soil Characterization Laboratory in College Station, Texas.

Report Organization

Six additional chapters follow in the report. The next, Chapter 2, provides a site description and an overview of fieldwork methods and activities that included three main components: backhoe trenching; controlled surface collection; and hand excavation. Chapter 3 contains a discussion primarily of methods for laboratory work conducted in Flagstaff, including treatment of specimen samples and procedures for routine processing and handling of excavated collections and samples. The next three chapters describe the results of the investigations. The first of these, by Dave Kuehn (Chapter 4), contains a detailed treatment of studies of soils, stratigraphy, and geochronology based largely on information from the several backhoe trenches excavated in the site. Chapter 5 contains a discussion of all certain and possible Paleoindian age artifacts from the site surface as well as specific artifacts from the 2000 trenching program thought to potentially be Paleoindian in age. Chapter 6 provides a discussion of the results of the hand excavation program, dealing with stratigraphy in each hand unit and also data about the meager artifact content and sometimes informative material content from deep contexts in those excavations. Excavation of Feature 5 and the surrounding area is only briefly treated in this section, as the field investigation of that pit feature has been reported in detail by Roche Lindsey (2001). The final chapter provides a brief summary of the findings of the project and some comments regarding the make-up of the Late Prehistoric age collection not reported here. Reports by Steve De Vore on geophysical field investigations conducted during the 2000 field program (De Vore 2001) and magnetic susceptibility tests conducted more recently (De Vore 2002) are included as Appendices A and B, respectively. A brief report by Jeffrey Eighmy regarding his archaeomagnetic sampling of Feature 10, the deep hearth, is included as an appendix.

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2. SITE DESCRIPTION AND FIELDWORK

Stanley A. Ahler and Jack L. Hofman

Site Description

The Barnes site is an extensive lithic scatter located in open, gently rolling terrain next to an intermittent drainage in the north-central part of the Pinon Canyon Maneuver Site. More specifically, the site occupies a portion of the SE ¼ of Section 18, T29S R58W, on the Lockwood Arroyo 7.5 minute USGS quadrangle (1993) (Owens 2000:1). Based on the occurrence of surface artifacts, the site extends for more than 200 m along the southeast side of an unnamed arroyo, and more than 100 m away from the arroyo channel onto slightly higher ground to the southeast (Owens 2000:1). The unnamed arroyo that forms one margin of the site drains generally to the northeast and converges with Lockwood Arroyo about 1.8 km downstream from the site (Owens 2000:7). Figure 1 provides an aerial view to the north-northeast of the central part of the site. The main part of the site, in terms of visible surface artifacts, lies near the center of this photo in the vicinity of the three backhoe trenches. The surface artifact scater continues to the southwest out of the image margin in the foreground.

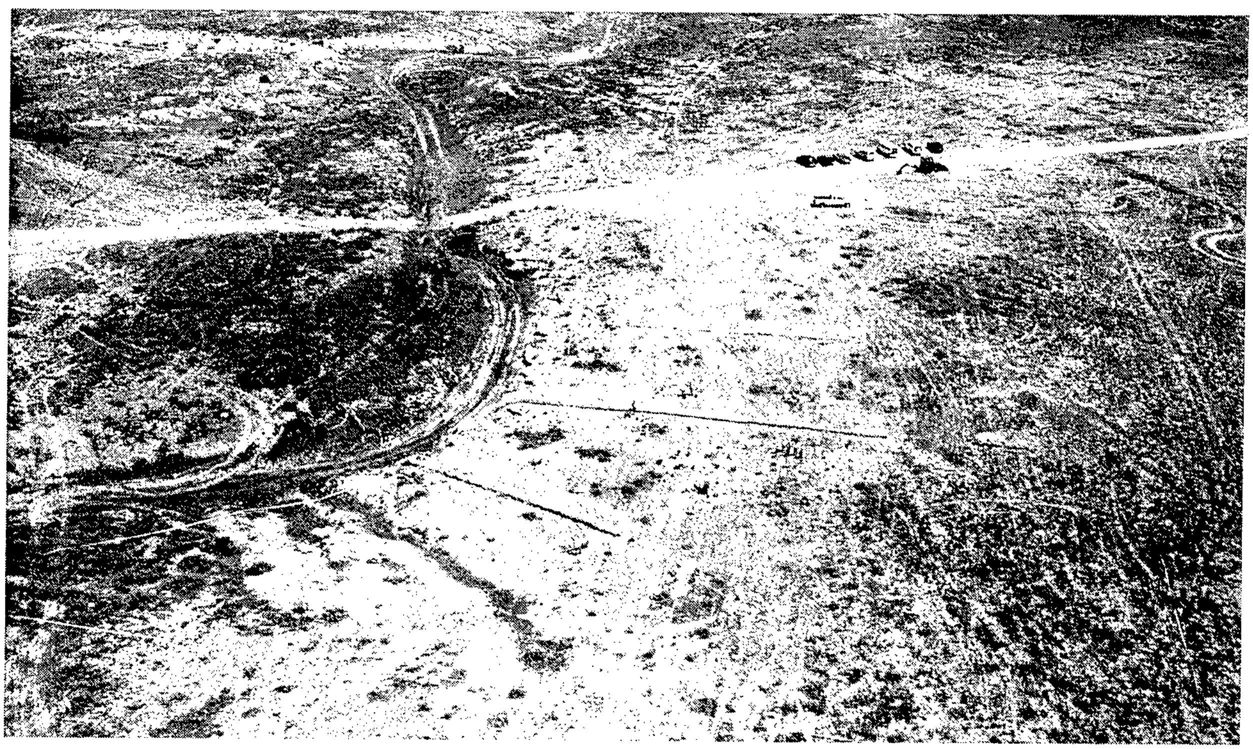

Figure 1. Aerial view to the north-northeast of the central part of the Barnes site (5LA9187) near the three backhoe trenches in the center of photo. Compare with Figure 4.

Figures 2 and 3 show aerial views of the subdued, rolling terrain near the site with views down-drainage to the northeast and up-drainage to the southwest, respectively. Lockwood Arroyo drains generally to the southeast and eventually forms Lockwood Canyon, a western side

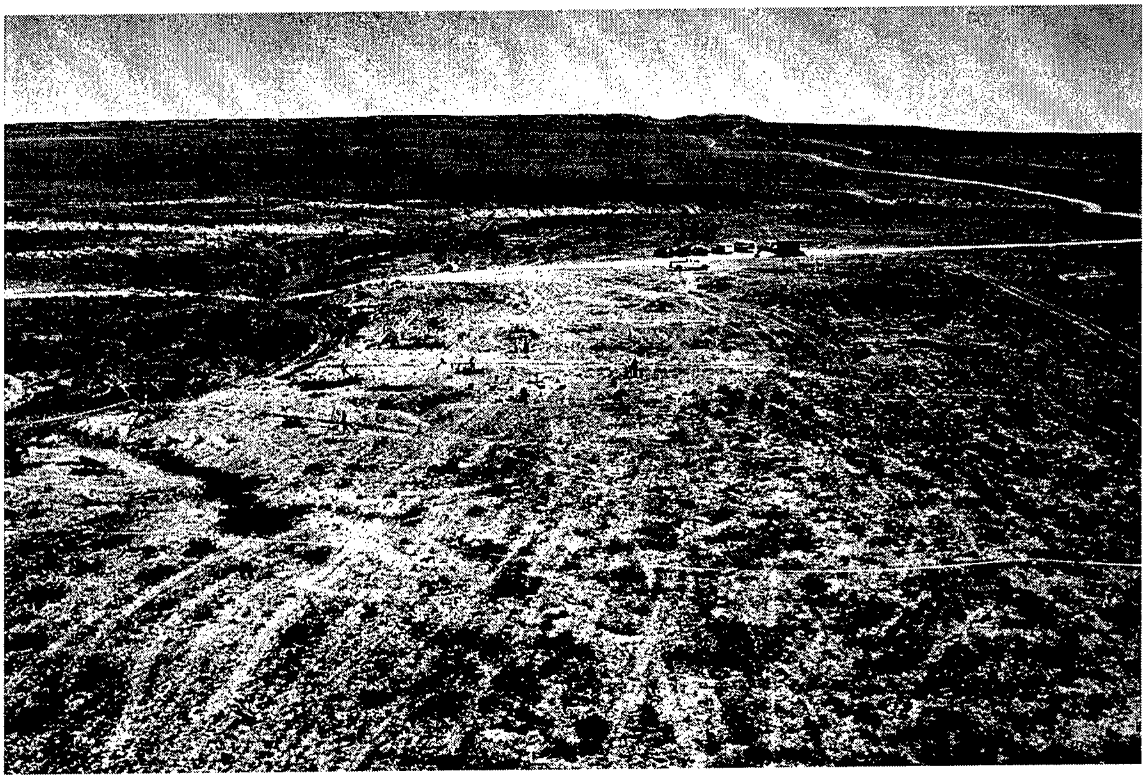

Figure 2. Long aerial view to the north-northeast across the Barnes site, 5LA9187.

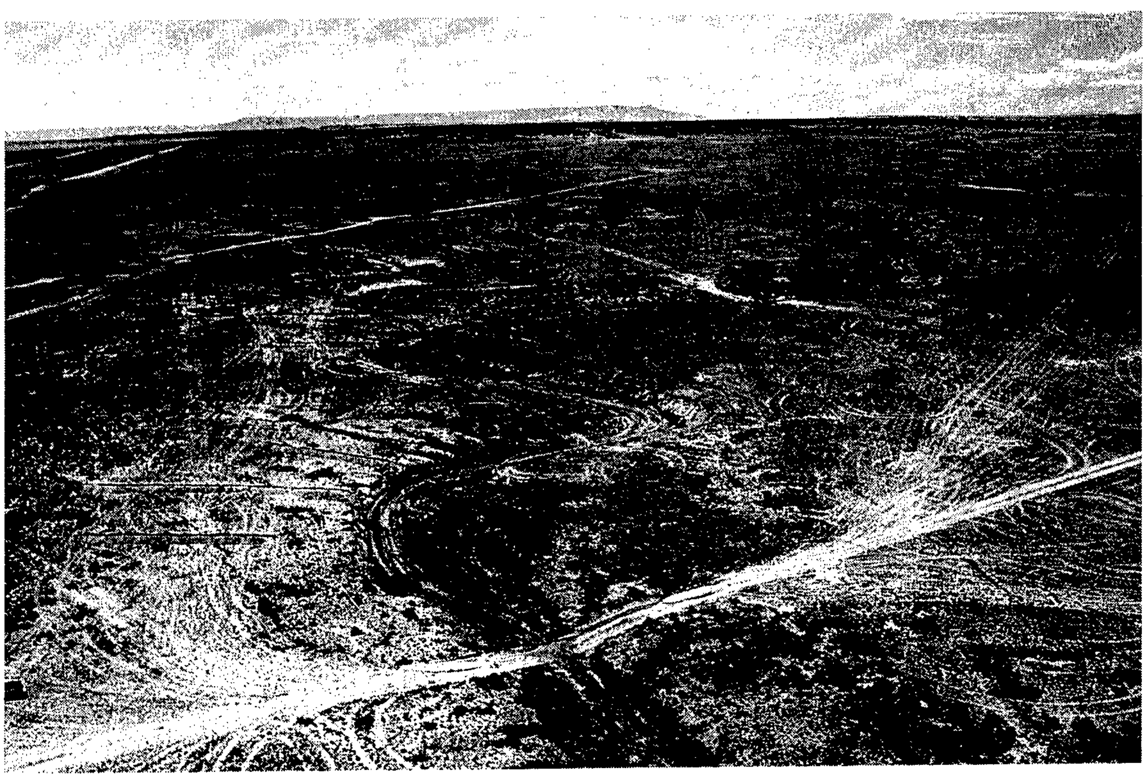

Figure 3. Long aerial view to the southwest across the Barnes site, 5LA9187.

branch of the Purgatoire River Canyon. The arroyo next to the site presently carries water only intermittently, and retains standing pools for a number of days after heavy summer rainstorms. A dead and fallen cottonwood tree in the arroyo bottom directly at the site (Figures 1, 2, and 3) suggests that groundwater may have consistently been present within the local drainage at times in the recent past, and that a water seep may have existed at this location. The presence of water in local pools or in a bedrock seep may have been a significant factor in the prehistoric occupation at this location. Today, the nearest permanent water source is a spring in Lockwood Canyon 6 km from the site (Owens 2000:2).

The unnamed arroyo next to the site heads up in a series of low hills a few km to the southwest (Figure 3). Today those hills support pinon-juniper vegetation. Vegetation on the site and in the immediate area is presently very sparse, as can be seen in all of the aerial views, and the site is presently subject to both wind deflation and sheet erosion. Local vegetation at the time of site discovery in 2000 consisted of saltbrush, low sage, and pale wolf berry, with lesser occurrences of foxtail barley, galleta grass, snakeweed, scarlet globe mallow, goldenrod, sunflower, western wheat grass, prickly pear, and little blue stem. The general vegetation in the site area is described as grassland and saltbrush shrubland transition (Owens 2000:2,7). Sparse vegetation at the site is almost certainly due in part to the impact of heavy mechanized equipment traffic across the site and throughout the area (note the numerous tracks in Figures 1-3). Mechanized equipment has more directly impacted the contents of the site through damage to surface and near-surface artifacts and destruction of near-surface cultural features (Owens 2000:4).

Figure 4 is a contour map of the site that depicts the course of the local drainage and local topography. The surface artifact scatter that marks the site exists throughout the southwestern two-thirds of the fenced area (the roughly rectangular area demarcated by a dashed line) and continues to the south and southwest parallel to the drainage past the 2A – 2D backhoe trench array. Surface artifacts are not evenly distributed within the site. A clear concentration occurred in the area between Trench 1A-1C and the southwest margin of the fenced area. Beyond that, farther to the southwest, surface artifacts tend to occur in clusters or patches a few meters in diameter. The site lies on distinctly sloping ground, with about 2 meters of relief occurring within the core area of the site and about 4 meters of relief occurring in the full site area.

As noted in the introductory chapter, one of the distinctive aspects of the site noted at the time of discovery was the presence of a Folsom point and several other possible Paleoindian age artifacts in the surface collection. These artifacts aside, the surface assemblage at the site was interpreted at the time of discovery (Owens 2000:7-9) as being highly unusual and potentially very significant in several regards: (1) The collection included an unusual array of non-local lithic raw materials including obsidian, plate chalcedony, dendritic chert, tiger-eye chert, and Black Forest silicified wood. (2) The collection contained a type of ground stone tool, a cylindrical pounder, not recorded previously on the PCMS. (3) A substantial amount of cord-roughened pottery occurred in the surface collection. (4) The ratio of tools to flaking debris in the surface collection was unusually high, and the 150-item flake count sought for in-field recording of flaking debris was difficult to find. (5) An unusually large percentage of the stone tool sample consisted of projectile points (Late Prehistoric side-notched arrowpoints), with the 57 recorded specimens making up nearly one-third of the 181 total tools recorded on the site surface.

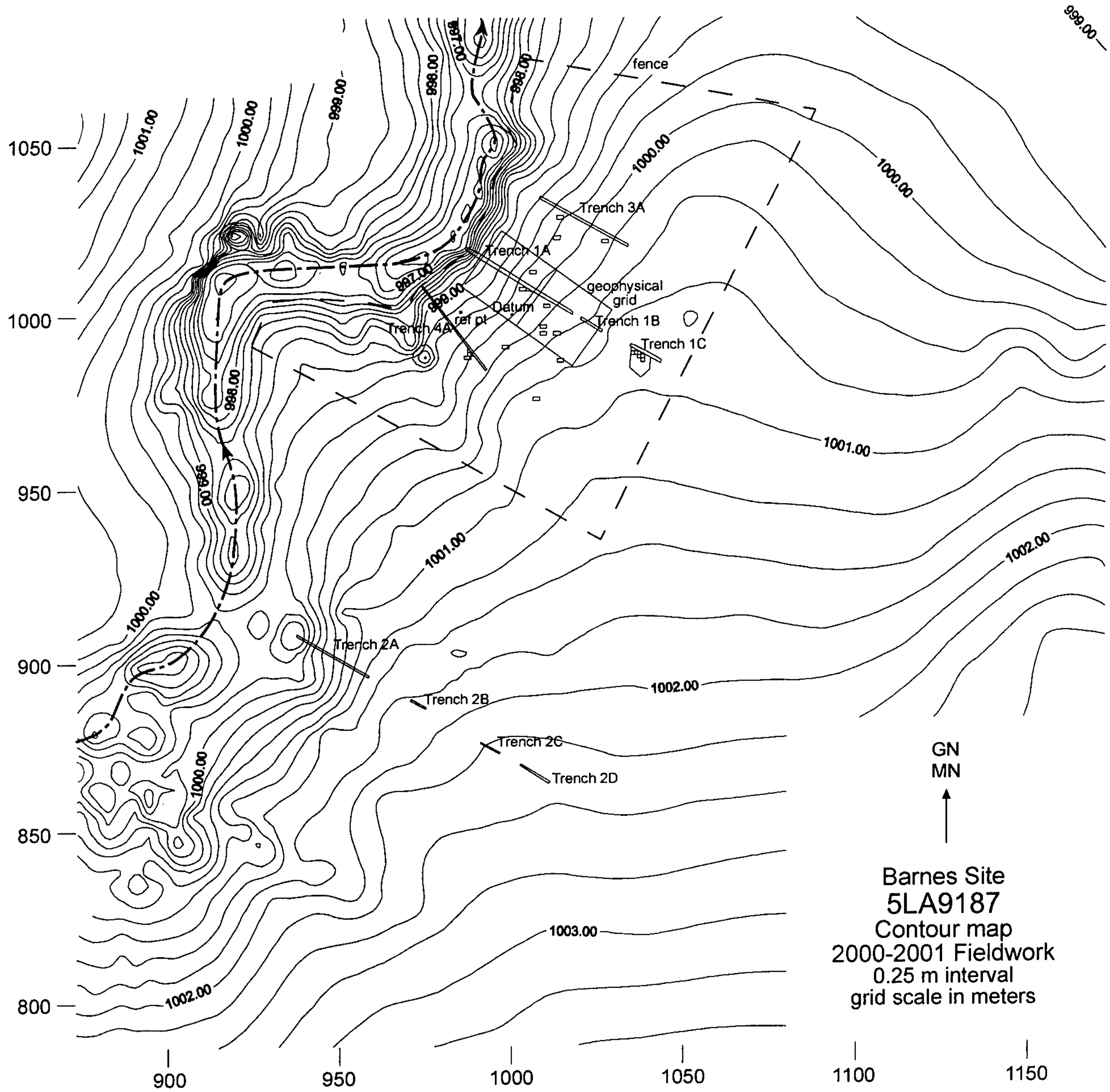

Figure 4. Contour map of the Barnes site (5LA9187) and the surrounding locale showing the fenced area where most work occurred. Map produced from data provided by Mark Owens, Steve De Vore, and Kelly Wright; 0.25 m interval. Site grid is aligned with magnetic north, with coordinates shown in the map margin.

(6) The surface collection appeared to be spatially structured, with an area in the southwestern part of the site producing only projectile points. In addition to these attributes, the site was noted as having four features consisting of stone rings of various sizes made of unmodified limestone boulders. One of these may have been a tipi ring and two appeared to be stone hearths. One of these was noted as having been disturbed by mechanized equipment.

Mark Owens' (2000) site report summarizes knowledge about the site and provides some initial interpretations regarding its function. The size of the site, the large number of projectile

points, and the associated stone tools indicate that the site is a Late Prehistoric butchering location for a large-scale hunt, likely for bison. The relatively small number of ground stone implements compared to hunting tools (points) indicates a relatively short period of occupation, as opposed to a longer-term habitation. The high frequency of non-local lithic materials among the stone tools indicates high mobility for occupants of the site. Faunal remains would be expected on a site of this nature but are noted as absent in the surface collections; a bone bed is predicted to occur nearby (Owens 2000:8-9).

2001 Fieldwork

The 2001 field program involved backhoe trenching and related documentation and geologic studies, hand excavations, and surface artifact mapping and collection. There were three main goals for the field program:

1. To conduct additional backhoe trenching and related geologic studies for the purpose of a) pinpointing buried Paleoindian age, artifact-producing horizons within the site; b) developing a working model of site geologic history; and c) estimating the approximate spatial extent and depth of buried artifact-bearing horizons with such information to be used to guide placement of hand excavation units.
2. To conduct surface work and hand excavations that would extensively sample and evaluate the known, near-surface Late Prehistoric age component at the site.
3. To conduct deep excavations in locations known or likely to contain buried artifact-bearing horizons, to sample and evaluate any potential Paleoindian age components at the site.
4. To develop data to support recommendations for continuing site management.

In brief, we wished to define the geochronologic structure for the site, extensively sample both the Late Prehistoric age and hypothesized Paleoindian age components at the site, and, in so doing, gather information that would contribute to refined assessment of site significance and recommendations for continuing management of the site. Figure 5 is a plan map of the major work units that were concentrated in the central part of the site, where the Folsom point was discovered and where surface artifacts were most dense. The map shows the site datum and arbitrary grid system (aligned with magnetic north), backhoe trenches excavated in 2000 and 2001, the 2000 geophysical survey grid area (De Vore 2001, Appendix A, herein), and all planned as well as executed hand excavation units.

Backhoe Trenching and Site Structure

Backhoe trenching was initiated on July 15 and the equipment work continued for roughly 2.5 days. Brian Goss operated the backhoe for the first 1.5 days, and operator Mike Nicholson conducted about 8 hours of additional trenching work. The backhoe carried a bucket ca. 16 inches wide that had a flat, sharpened cutting blade welded over the teeth. This bucket cut a smooth trench floor but had difficulty cutting into hardened, carbonate-rich sediment units. Operator Nicholson removed the plate from the bucket and worked with a toothed bucket for the final 6 hours or so of the operation. Even with a toothed bucket, Nicholson noted that the

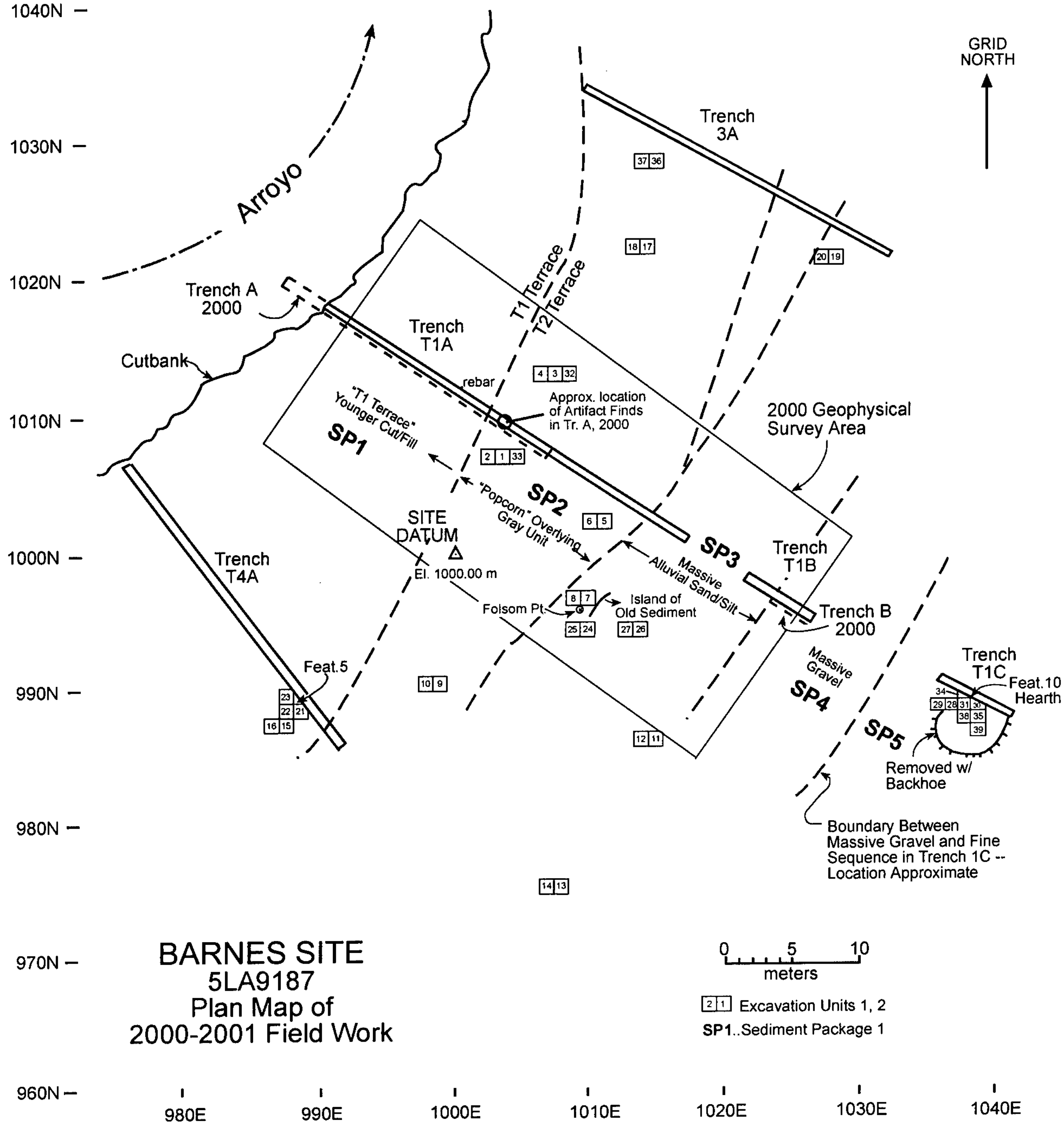

Figure 5. Plan map of the central part of the Barnes site (5LA9187) showing locations of trenches, hand excavations, site datum, Folsom point find spot, and other features that figured in the work effort.

hydraulic system of the hoe was not working properly, and that the machine could not downcut well. These factors limited the initial depth of one trench (Trench 1A), in particular, and led to an additional episode of trenching work that took place on August 1 with Roche Lindsey operating the equipment with permission from DECAM.

During 2000, two backhoe trench segments (Trench A and Trench B) were excavated in an alignment perpendicular to the arroyo and on a line that ran, at its closest point, about 8 m northeast of the original Folsom find spot. These trenches are shown on Figure 5, along with all trenches dug in the same vicinity during 2001. Trench A was about 26 m long; Trench B was separated from Trench A by a gap of ca. 20 m and was ca. 3 m long. Trench A crossed a section of younger sediment nearest the arroyo, dubbed Terrace 1, and penetrated an older and higher sediment unit called Terrace 2 (see discussion by Dave Kuehn in Chapter 4). Trench B penetrated a completely different lithologic unit made up of sand and gravel, tentatively identified as Terrace 3.

Four backhoe trench alignments, in a total of nine discrete trench segments, were dug during 2001. Each alignment was labeled in the sequence in which it was dug (Trench 1, Trench 2, etc.), and each segment was given a letter designation (1A, 1B, etc.). Shortly after each trench was dug, the northeast wall was cleaned and faced by crew members working with shovels (Figure 6). This wall was examined in detail by Dave Kuehn who scribed major and minor stratigraphic unit boundaries in the trench wall. Crew members Michael Chidley and Cheryl Wagner made scaled profile drawings of each trench (Figure 7) and assisted Dave Kuehn in collecting sediment samples from major stratigraphic units in several trenches. Altogether, trenches opened in 2001 totaled ca. 131 m in length. Of this, 117 m of exposure were mapped or profiled during the 2001 season; the remaining 14 m were mapped during the 2000 season.

Initial goals for the backhoe trenching in 2001 were, first, to re-expose and confirm the three-terrace sediment system partially exposed during 2000, and then to determine if this system of three terraces could be mapped for any distance up- and down-valley along the arroyo. Thus, the first step was to re-expose and expand the trenches dug in 2000, then to move to a location some distance up-valley to cut an exposure and look for a similar terrace sequence.

Trench 1 was excavated in three segments along the same alignment at Trenches A and B in 2000 (Figure 5). Trench 1A was 32 m long, began at the present arroyo cutbank, and re-exposed part of the length of Trench A from 2000. Trench 1A crossed the juncture between Terrace 1 and Terrace 2 seen in 2000, and extended, in its southeastern end, into a different sediment unit composed primarily of alluvial sands that reached to the present surface (Figure 5). Trench 1B was 6 m long and extended slightly farther to the northeast from the area exposed in Trench B from 2000. Trench 1B exposed

Figure 6. Mark Owens cleaning the wall of backhoe Trench 1A at the Barnes site, 5LA9187.

both the alluvial gravel layers as well as a massive body of alluvial sands and silts that appeared to be the same as that in the southeast end of Trench 1A. Having dug Trenches 1A and 1B, we exposed several discrete sediment units that differed horizontally in composition. While the continuing study of stratigraphy and soils in these trenches demonstrated the sediments there to be extremely complex in terms of individual stratigraphic layers (see Dave Kuehn's treatment in Chapter 4), it is still useful to think of these trenches having exposed four rather distinct "sediment packages." This is non-technical term intended to draw attention to a dominant characteristic of a particular exposure or to the fact that a clear horizontal demarcation exists between two units with similar features. We have labeled each sediment package (SP) on Figure 5. Four of these were exposed in Trenches 1A and 1B. SP1 and SP2 equate with Terrace 1 and Terrace 2, respectively, as they were observed in 2000. SP3 is a new sediment unit more distant from the arroyo composed of massive alluvial bedded sands and silts, apparently lacking soil structure. SP4 is the unit dominated by alluvial gravel, farthest from the arroyo.

Figure 7. Michael Chidley and Cheryl Wagner (l,r) recording the profile of Trench 1A, July 2001, 5LA9187.

Trench 2 was intentionally placed at a substantial distance up the arroyo (ca. 121 m) from Trench 1 (Figure 4). Trench 2 was dug in four segments, totaling ca. 35 m of profile exposure and reaching a distance of 86 m from the arroyo cutbank. Trench segment 2A exposed 20+ m of massive alluvial sand near the arroyo unlike any sediment unit in Trench 1. Short trench segments 2B and 2C each exposed fine-grained silt and clay units with dense carbonate deep in the profile, and it was unclear if these represented Terrace 1 or Terrace 2 as exposed in Trench 1A. Segment 2D, farthest from the arroyo, penetrated a series of buried gravel lenses, starting about 62 m from the arroyo edge and extending farther upslope, that were capped by silt/clay and were not visible at the surface (in contrast to the gravels in Trench 1B). Thus, it was unclear if the four-unit sequence exposed in Trenches 1A and 1B had been replicated in Trench 2.

Being particularly curious about the discovery a major gravel unit in Trench 2D that was not visible at the surface, we returned to the Trench 1 alignment. We noted that the gravel layer penetrated by Trench 1B was not visible on the surface a short distance farther upslope away from the arroyo. To explore this area, containing possibly more deeply buried gravels or yet another sediment unit, we placed an additional trench segment (1C) along the alignment of Trench 1 (Figure 5). Trench segment 1C reached a point 60 m from the arroyo cutbank, and it exposed a sediment sequence that was remarkably similar in appearance to that in the middle of Trench 1A – that is, it consisted of clayey silt and silty clay, and it contained a thick layer of

sediment with blocky subangular structure overlying a darker sediment with less structure and highly visible carbonate. This appeared at first glance to be the Terrace 2 sequence, yet its position - far upslope and separated laterally from Terrace 2 in Trench 1A by two other sediment units - was perplexing, to say the least. This was labeled SP5 (Figure 5), with the boundary between SP4 and SP5 falling somewhere between Trench 1B and Trench 1C.

No buried cultural deposits or clear buried A soil horizons were observed in Trench 2, and only Late Prehistoric surface artifacts were known to occur in the vicinity of Trench 2. On this basis, we decided that deep hand excavations would not be placed in the vicinity of Trench 2, and that hand excavations and therefore further trenching work should be concentrated closer to both the original Folsom find-spot as well as the location where buried artifacts were found in 2000. Consequently, we decided to spatially bracket Trench 1 with long, approximately parallel trenches on either side that would hopefully expose the Terrace 1-2-? sequence and allow us to correlate sediment units over much shorter horizontal distances for purposes of planning excavation locations.

Trench 3 consisted of a single 25.5 m-long segment (labeled 3A) that began upslope about 8 m from the arroyo cutbank (Figure 5). This trench was specifically designed to cross the Terrace 1 - Terrace 2 juncture and to reach into the alluvial sand sediments exposed in the northeast end of Trench 1A. Such a clear-cut structure was not immediately apparent in the walls of Trench 3A. A subangular blocky sediment unit, just below the present surface, appeared to extend the full length of the trench. A deeper carbonate-rich unit occurred, and it was darker and most closely resembled the Terrace 2 sediment in the northeastern part of Trench 1A.

Trench 4 consisted of a single 26.5 m-long segment (labeled 4A) that began at the arroyo margin and extended to the southeast (Figure 5). This trench was placed not only to replicate stratigraphy exposed in Trench 1A about 20 meters away, but also to provide a subsurface exposure in the vicinity of two surface artifacts that had been identified as Plano points. Trench 4A exposed what appeared to be perhaps a variant of Terrace 1 sediments throughout nearly its entire extent. A 7-m wide layer of buried gravel was exposed some distance from the arroyo (a sediment unit not seen in any other trench), and a darker sediment with carbonate, perhaps reminiscent of the Terrace 2 "paleosol" was barely exposed in the very end of the trench farthest from the arroyo. Crew member Roche Lindsey noted charcoal in the north or northeast wall of Trench 4A, leading to the discovery of Feature 5, a Late Prehistoric pit that had been bisected by the trench (see Figure 5). This proved to be one of the most significant finds in the project.

By the completion of the majority of trenching work on July 18, we still had a very unclear picture of the subsurface geologic structure of the site. The three-part terrace sequence developed from the very limited trenching work in 2000 had pretty much broken down, in part due to the lateral complexity along the greater spatial extent of Trench 1, and in part due to the difficulty in correlating any sediment unit from trench to trench even over short distances. We had by that time re-exposed the area where artifacts were observed in buried context at the top of a dark sediment unit in Trench 1A, but we had failed to observe or discover any additional buried artifacts at that location or at any other location in any trench wall. Previous attempts to date the site deposits had produced poor or equivocal results (see discussion of this topic by Kuehn in Chapter 4), and the only charcoal that was observed in any of the new and expanded trenches was in Feature 5 (associated with pottery in a pit) in Trench 4A and in the floor of Trench 1A in

what appeared to be the top of a dark, carbonate-rich sediment (Terrace 2 paleosol?) that had not been penetrated well by the backhoe. Dave Kuehn was suggesting by that time that the model for geologic processes most suitable for explaining the structural complexity of the site was one of "lateral truncation" rather than "cut and fill" (see Chapter 4).

At that point in time, Dave Kuehn was focusing on the existence and extent of visible carbonate-rich horizons as a basis for estimating age of deposits and for correlating sediments from trench to trench. Being uninformed about that approach, another one of us (Ahler) focused on the apparent existence of a slightly darker, grayer sediment unit that appeared to occur at similar depth and beneath a layer having "popcorn" structure in all three trenches in the main site area. The artifacts that had been found in subsurface context during 2000 were discovered very near the upper surface of this unit in Trench B (now our Trench 1A; approximate discovery location is shown on Figure 5). Although heavily charged with visible carbonate in most exposures, perhaps this dark unit was in fact a buried A horizon (as originally suggested by Dave Kuehn in 2000, and as opposed to a sediment deriving its color primarily from a greater proportion of shale as parent material) and marked the single stratigraphic marker where Paleoindian artifacts would be most likely to occur within the site. One of us (Ahler) thought that this gray zone was detectable not only in the central part of Trench 1A, but also throughout most of the extent of Trench 3A as well as in the very end of Trench 4A (see Figure 5). Based on this line of thinking, emphasizing the buried "gray unit" as the most likely place for early artifacts, locations for 20 excavation units (numbers 1-20) were laid out on July 18, all designed to collect both Paleoindian and Late Prehistoric age artifacts. Three additional units were laid out explicitly to expose and excavate pit Feature 5 (see a later subsection for more detailed discussion).

When Jack Hofman joined the project for the first complete work session and hand excavations starting July 25, one of his first activities was to examine in detail all of the exposed backhoe trench walls and to gain an understanding of overall site structure. Jack's attention was drawn to the apparent existence of the "gray unit" at depth in Trench 1C, its existence in the floor of Trench 1A, and its apparent existence in the very upslope end of Trench 4A. Jack discovered a dense concentration of charcoal more than a meter below surface in the southeast wall of Trench 1C, opposite the wall that had been formally documented in profile drawings. He noted the shallow depth of the trenches in several areas and the difficulty of observing profiles in the extremely narrow trenches. Shortly thereafter, Jack suggested additional backhoe machine work to deepen, extend, and broaden trenches in critical areas.

Several days later we received the backhoe keys from DECAM so that we could conduct this work. Trench 1A was deepened considerably and broadened for greater visibility in the area where the deep gray unit joined the massive alluvial silt/sand unit on its upslope margin. Trench 1C was deepened substantially and lengthened about 2 meters in the direction away from the arroyo. In addition, the backhoe was used to remove nearly a meter of overburden over an area of several square meters next to Trench 1C (Figure 5), thereby exposing a large horizontal surface so that the charcoal concentration in the southwest wall of the Trench 1C could be reached by hand excavation (it proved to be Feature 10, a hearth). Finally, the backhoe was used to lengthen Trench 4A about 1.5 m in the direction away from the arroyo and the trench was broadened for better visibility in that area. Following trenching work, all the new exposures were examined closely for artifacts and charcoal. No artifacts were seen, but the deep gray unit

was found to contain a consistent scatter of individual pieces of charcoal at every location where it was exposed at depth in Trench 1A, 1C, and 4A. These charcoal pieces were flagged on profile walls and eventually were mapped on profile drawings.

Dave Kuehn returned to the site near the close of the project during August 14, 15, and 16 to observe and document the new stratigraphic exposures in the three deepened and altered trench areas. Dave collected several charcoal samples from trench walls for purposes of AMS dating and correlation of stratigraphy from trench to trench. He scribed newly observable stratigraphic units on trench walls and directed the updating of backhoe trench profile drawings.

Very near the end of the project, Ahler, Hofman, and Kuehn examined the particular section of deepened Trench 1A where the gray unit met the massive alluvial silt/sand unit, near the SP2 – SP3 boundary in Figure 5. It was noted that the form of this contact clearly indicated that the massive silt/sand (upper SP3) was a distinctly younger sediment, filling a cut into the gray unit (lower SP3) at this point. The "popcorn" sediment (upper SP2) clearly overlay the gray unit (the same gray unit in lower SP4) but appeared to be inset laterally into the massive sand/silt at this location, and was therefore younger in age than the massive sand/silt. The geometry of these three units at this location made it clear that the gray unit was simply the clay-rich, carbonate-rich B horizon of an older lithologic unit that must have originally had a ground surface (associated A horizon) at an elevation as high or higher than the present ground surface in this area. Thus, the gray unit was not a buried A horizon, but was almost certainly a scoured-off, erosion resistant B-horizon, meaning that it was very unlikely that *in situ* artifacts would be found buried at its surface. Thus, very late in the project, it became clear that much of the focus on reaching and exposing the upper surface of the gray unit in hand excavations was probably a misdirected effort, owing to overemphasis of the gray unit as a possible buried A horizon.

In summary, by the close of fieldwork we could identify in a little more detail at least five sediment packages (SP1 through SP5) within the central part of the site near Trench 1. Approximate horizontal partitions of the site are demarcated by dashed lines in Figure 5. Figure 8 provides a composite and schematic cross section along the axis of Trench 1A – 1C showing the horizontal demarcation of the five sediment packages and the major stratigraphic layers that make up each package. This figure also shows the radiocarbon dates associated with various parts of this exposure. The information in this figure, less the radiocarbon dates, was available during fieldwork, and the concept of sediment packages served to structure the placement of excavation units at the site. A much more refined and detailed description of stratigraphy and soils, along with discussion of radiocarbon dates, is provided by Dave Kuehn in Chapter 4.

The SPs indicated in Figures 5 and 8 provide a framework for discussion in a following section regarding placement of excavation units. Nearest the arroyo is the Terrace 1 sediment package (SP1), geologically some of the youngest material in the site, consisting predominantly of alluvial silts and clays that are pedogenically altered sufficiently to obliterate alluvial depositional features. Adjacent to this and farther from the arroyo is the package SP2 containing the lower "gray unit" that is directly and unconformably overlain in this part of the site by the "popcorn" unit. The gray unit contains visible carbonate and dispersed pieces of charcoal. The popcorn unit is slightly lighter and browner sediment with distinctive small blocky subangular peds that are apparent in weathered or picked profile walls. The artifacts found in 2000 in the backhoe trench came from deep within SP2. Adjacent to SP2, and yet farther from the arroyo, is

the massive alluvial sand/silt package (SP3) that extends to very near the site surface. This sediment is inset over and against the gray unit on its northwest margin in Trench 1A, and apparently overlies a more deeply eroded section of gray unit in Trench 1B. The Folsom point on the surface was found near what we would project to be the juncture between SP2 and SP3. In the field, we speculated that it may have originally been buried within either unit.

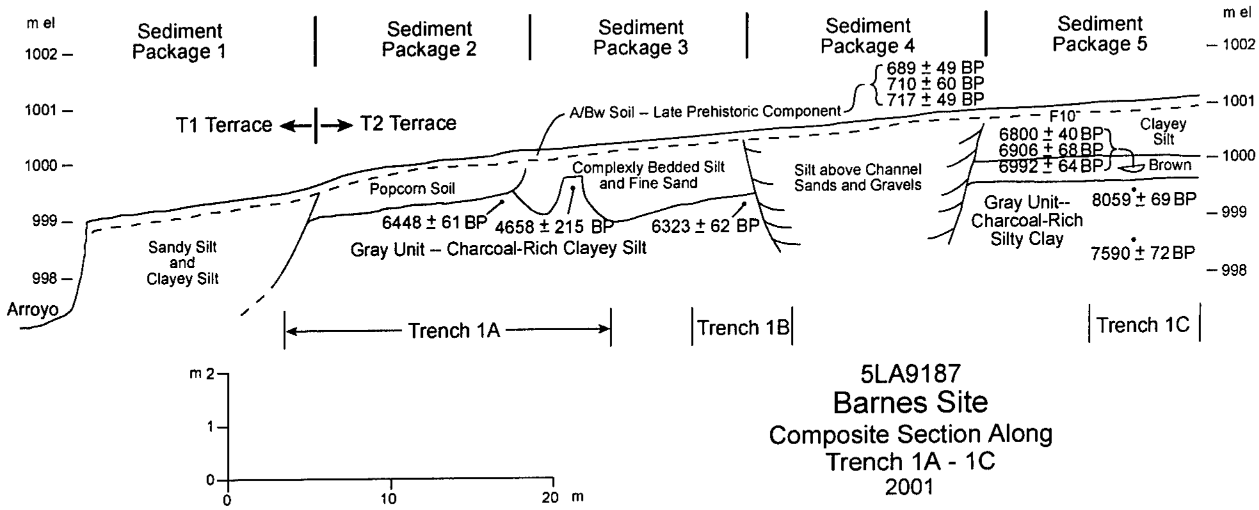

Figure 8. Composite stratigraphic section along the axis of Trenches A, B, 1A, 1B, and 1C at the Barnes site (5LA9187) showing sediment package boundaries and radiocarbon dates.

Yet slightly farther from the arroyo is a coarse, bedded channel sand and gravel package (SP4) that fills a cut into the massive alluvial silt/sand in Trench 1B. Like the silt/sand (SP3), this channel fill sediment extends nearly to the present ground surface. Its extent can be traced on the surface by a dense scatter of gravels. Farthest from the arroyo is the fifth sediment package (SP5), exposed in Trench 1C. In this location, another gray unit (not necessarily correlatable with the gray unit in Trench 1A) appears deep in the sequence. The gray layer is overlain by slightly lighter brown sediment that, like the gray unit, contains noticeable amounts of carbonate. This lighter unit also contains Feature 10, the deep hearth. Above this is a more massive, thick unit that has prominent subangular blocky soil structure and that has little or no visible carbonate.

Surface Collections

As discussed previously, when the Barnes site was discovered in 2000 it was clear that the site contained a Late Prehistoric age component at the surface that was concentrated in the area where the Folsom point was found and that extended for 150 or more meters up the arroyo from that location. It was also surmised that the surface artifact scatter contained a mixture of Late Prehistoric (the dominant component), Folsom (at least one artifact), and younger Paleoindian age (Plano) artifacts. A substantial surface artifact collection was made at the time that would assist in interpretation of cultural components at the site. During 2000, standard recording and collecting procedures used for all surface assemblages encountered during the PCMS survey program were followed at the Barnes site. Approximately 249 surface artifacts were plotted and assigned field specimen (FS) numbers. The numbered objects included

virtually everything observed on the site with the exception of fire-cracked rock and flaking debris. The later artifact type was studied in the field without collection and numbering. With the exclusion of cores and ground stone artifacts, all of the FS-numbered artifacts were collected and returned to the lab for additional study.

When fieldwork began in July 2001, it was clear that a significant number of new stone tools as well as many pieces of flaking debris (some studied but not collected during 2000) were again visible on the site surface. All visible surface artifacts were flagged during the mid-July partial session, and all artifacts within the portion of the site marked off with fence posts and flagging tape including flakes, tools, FCR, and pottery were mapped with the total station and collected by the end of the day on July 19 (Figure 9). This brought the total collected FS count

Figure 9. Surface collection in progress at the Barnes site during July 2001. View west in the core area of the site near the datum (at instrument). Note flags and plastic bags marking artifacts.

to ca. 514 specimens. One of the purposes in taking this collection was to provide a more complete database for sorting out possible components of different ages in the surface artifact scatter. As noted by Owens (2000), many apparently exotic raw materials occurred in the surface collection, and lithic raw material type might prove to be one pathway for segregating artifacts of different ages in the surface aggregate. Technological features indicative of early components might also be evident in flaking debris. In addition, although the total count of surface artifacts was impressively high, they were indeed very widely scattered, and it was likely that any given excavation unit would produce only a small number of specimens. Thus, the total aggregate of surface artifacts, along with their spatial arrangement, might prove to be a very effective way of analyzing and interpreting the dominant Late Prehistoric component at the site.

As excavation commenced on July 25, additional surface artifacts continued to appear and were flagged as they were seen. Mr. Bobby Hill, a DECAM staff member and an avocational archaeologist familiar with the territory, visited the site frequently and flagged many additional projectile points and other artifacts, particularly in the southwestern area well outside our excavation zone. At the close of the project, all flagged surface artifacts, including those both within and outside of the area bounded by fence posts, were mapped with the total station and were collected. At the conclusion of fieldwork in mid-August, the final field specimen count of plotted artifacts was approximately 739. Detailed study of the spatial distribution and content of the surface collection will prove to be a major source of information about the Barnes site. It can be noted that the collection taken in 2000 and the collections from 2001 were recorded in different manners. For the 2000 collection, distance and direction from the site datum were recorded in project databases, and for the 2001 collections, surface artifact locations were recorded by north and east coordinates in the arbitrary grid system for the site. In the grid system, the site datum was given coordinates of 1000N and 1000E and an elevation of 1000.000 m, with grid north aligned with magnetic north (Figure 5). So far, the two recording systems for the surface collection have not been reconciled, but this will need to be done for purposes of spatial study of surface artifacts.

Hand Excavations

The five sediment packages demarcated in Figures 5 and 8 (SP1 - SP5) were fairly well identified (although not formalized by name) at the time that the initial set of excavation units was laid out, prior to the work session that began on July 25. The surface artifact scatter as mapped by July 19, including diagnostic Late Prehistoric artifacts such as pottery and arrowpoints, appeared to be most densely concentrated in areas demarcated as SP3 and SP4, but the Late Prehistoric scatter clearly extended over all five mapped sediment packages, SP1 through SP5. It was clear therefore that there was little relationship between subsurface geology and the predominantly Late Prehistoric scatter, and therefore that all of the sediment units other than the surface-most A horizon, including the fill of Terrace 1 and SP1, probably predated the Late Prehistoric period in age. This information helped guide the placement of excavation units.

The basic unit of excavation was a 1 x 1 m square, aligned with the site grid system, and these were usually laid out in pairs (e.g., XU1/2) to gain a larger spatial coverage at any given spot and also to allow greater access at depth. The first 20 numbered excavations units (Figure 5) were laid out in a manner designed to sample both early artifacts (if more existed in the site) as well as the known Late Prehistoric component. Additional excavation units were opened as the field season progressed, based on evolving strategies and understandings of site stratigraphy. Units continued to be numbered in the sequence in which they were laid out and were eventually assigned unit numbers from 1 through 40. Four units were planned and numbered but not excavated (15/16, and 17/18). Summary information for all excavation units is provided in Table 1, which includes approximate depth below surface, approximate excavated volume, features encountered, and comments on what was discovered in each unit or unit pair or group.

Sediments were generally very hard if not nearly impenetrable, and excavation was conducted using a combination of shovels, picks, pick-mattocks, trowels, and other hand tools. Floors of units were sometimes wetted at the end of the day with excess drinking water, easing the excavation task for the next day. Artifact recovery occurred through a combination of

Table 1. Summary information about hand excavated units, 5LA9187, 2001 field program.

Unit Nos.	Nominal Depth, cm	~ Excavated Volume, m^3	Features Encountered	Purpose of Unit, Other Comments
1/2	130	2.60	none	penetrated gray unit in SP2; placed closest to original deep finds in Tr. A
3/4	200	4.00	none	penetrated gray unit and below in SP2; close to original deep finds in Tr. A
5/6	90	1.80	# 9, hearth	penetrated gray unit near charcoal seen in SP2 in Trench 1A
7/8	100	2.00	# 6, rock conc.	placed next to original Folsom find spot; exposed major unconformity in SP3
9/10	140 & 120	2.60	none	placed within SP2; penetrated gray unit and exposed irregular unconformity
11/12	30 & 40	0.70	none	shallow unit sampled near-surface deposits only near SP3/SP4 boundary
13/14	15 & 20	0.35	# 7, hearth	shallow unit sampled near-surface deposits within SP4
19/20	30 & 40	0.70	none	shallow unit sampling near-surface deposits only; SP unclear
21/22/ 23/40	30 - 80	1.30	# 5, pit	shallow; designed to expose Feature 5 Late Prehistoric pit
24/25	30	0.60	none	shallow unit sampling near-surface SP3 deposits close to Folsom find
26/27	30	0.60	# 8, hearth	shallow unit sampling near-surface SP3 deposits close to Folsom find
28/29	15	0.30	none	shallow unit test prior to backhoe work over deep hearth, Feature 10
30/31/34/ 35/38/39	35, 50, 30, 40, 30, 40	1.85	# 10, hearth	units designed to expose and sample around F10, deep hearth
32	80	0.80	none	excavated to provide deep access into Units 3/4
33	70	0.70	none	excavated to provide deep access into Units 1/2
36/37	80 & 70	1.50	none	excavated to reach gray unit (SP2?) exposed near Trench 3A
Total		22.40 m^3		

dryscreening over quarter-inch mesh (Figure 10) and waterscreening over 16-per-inch mesh. For most excavation levels within units, a 1/9th sample of each level (a 33 x 33 cm block in one corner of each square) was waterscreened and the remaining 8/9th balance of the level was dryscreened. Fill of all features was waterscreened or collected in bulk for lab flotation. Waterscreen samples were transported to a facility at the Red Rocks field camp where processing and drying occurred. It was very difficult to process all dirt through the dryscreens at the site, and screen residue from dryscreens was also transported to the waterscreen location where excess dirt was washed away and the samples dried and bagged for transport to the lab. No field sorting occurred, even with dryscreen samples, and all materials captured in the screens including natural rocks were returned for inspection, sorting, and quantification in the lab.

Excavation was conducted in 10-cm thick arbitrary levels, with depth measured in elevation. For most work, elevation (depth) was measured using a line level with a string tied at

a known elevation to a local datum stake near each excavation unit. Progress in excavation, including notes on artifact recovery, sediment changes, and floor plans at the end of each level,

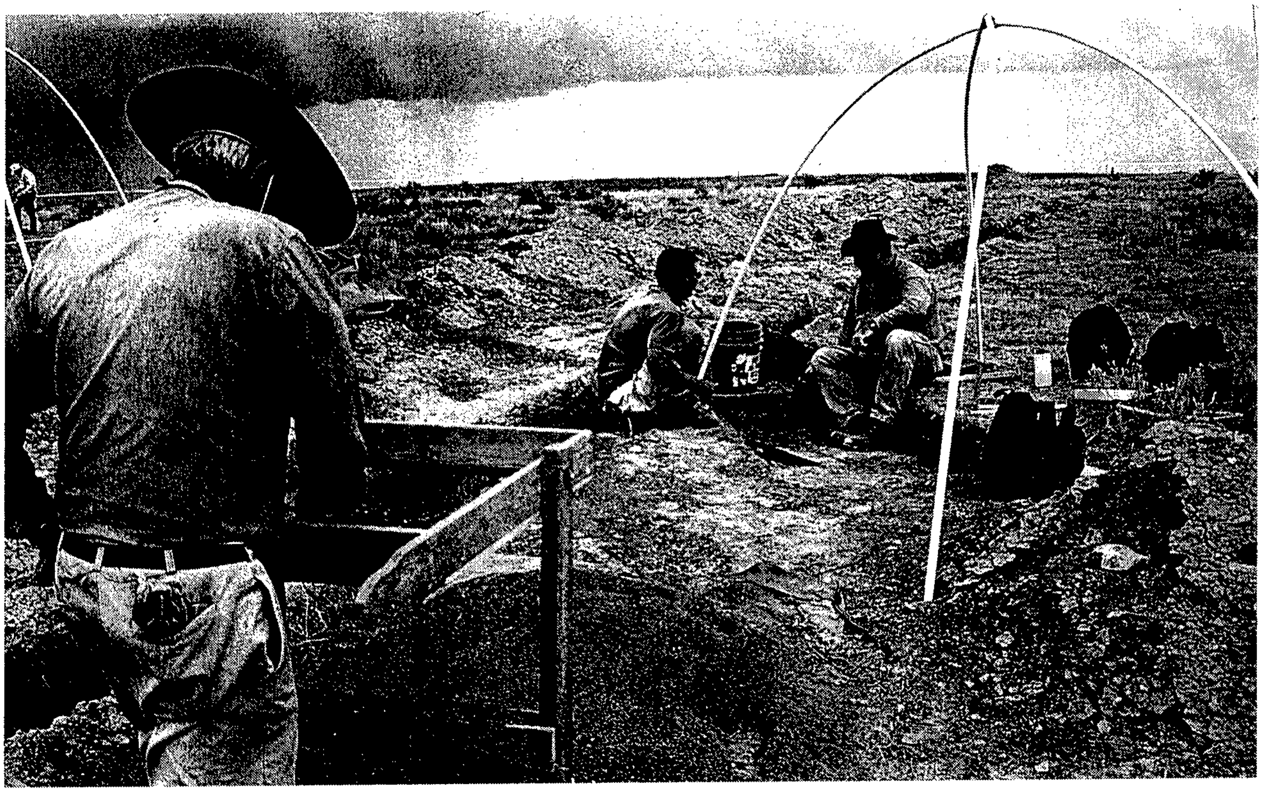

Figure 10. Jerry Morrow, John Gust, and Robert Gardner (l-r) working at Unit 1/2 next to Trench 1A, very near the original find of artifacts deep in Trench A at the Barnes site, 5LA9187. View ca. east.

was recorded on standard level forms. The same form was used to record excavation of features. A provenience-based catalog was kept on-site, and individual catalog numbers were assigned to each new excavation level or subpart of a level differing by recovery method and to each plotted artifact. We attempted to 3-D plot all diagnostic artifacts such as stone tools and potsherds, and many small pieces of charcoal that were found in situ were also 3-D plotted and assigned separate catalog numbers. Catalog numbers occur in the sequence from No. 1001 through 1680, and therefore do not overlap the sequence of FS numbers (surface artifacts) that are all less than 1000 (1 to approximately 739, at this time). When excavation was completed in various units, at least two adjacent walls of each unit pair were cleaned, photographed, and recorded in scale drawings on graph paper.

We can discuss in more detail the strategy used for excavation placement. Sediment Package 1 (SP1, Figure 5) was considered to be Holocene in age and unlikely to contain Paleoindian age deposits. No artifacts had been seen in this unit during trenching work, and no clear buried, stable surfaces were observed in this unit. Therefore, we avoided SP1 during deep excavation as likely to be unproductive territory. An exception to this was planned Units 15/16, just southwest of Trench 4A (Figure 5), possibly within SP1, that were intended to penetrate sediments in the vicinity of two surface artifacts thought to be Plano points. After excavation

began, these artifacts were examined by the authors and re-evaluated as being either temporally non-diagnostic or Late Prehistoric in age. Plans to excavate Units 15/16 were then abandoned.

Several excavation units penetrated and sampled SP2 (Figure 5). Until Feature 10 was discovered in the wall of Trench 1C, this was the primary zone within the site where we focused attention on finding a deeply buried cultural horizon. Excavation unit pair 1/2 was placed as close as possible to the original buried artifact find spot in Trench A (Figure 5), while also being upslope from the Terrace 1 – Terrace 2 juncture in this vicinity. The objective was to excavate Units 1/2 well into the gray zone. Units 3/4 were placed on the northeast side of Trench 1A, also in very close proximity to the original deep artifact find spot. The goal for Units 3/4 was the same as for Units 1/2 – to penetrate well into and perhaps through the gray zone. Additional 1 x 1 m squares (Units 32 and 33) were eventually added to each of these unit pairs to provide greater access as depth increased in Units 1/2 and 3/4.

Three other unit pairs were designed to reach or penetrate the gray zone and to provide spatial coverage of that zone. Units 5/6 were placed close to Trench 1A (Figure 11), near the upslope margin of SP2, and in close proximity to a location where charcoal had been observed within the gray zone in the wall of Trench 1A. Units 9/10 and 36/37 were designed to reach the gray zone and to provide spatial coverage of that horizon. Units 36/37 replaced Units 17/18, which were not excavated, sampling a location where the upper boundary of the gray unit as observed in Trench 3A was closer to the current surface.

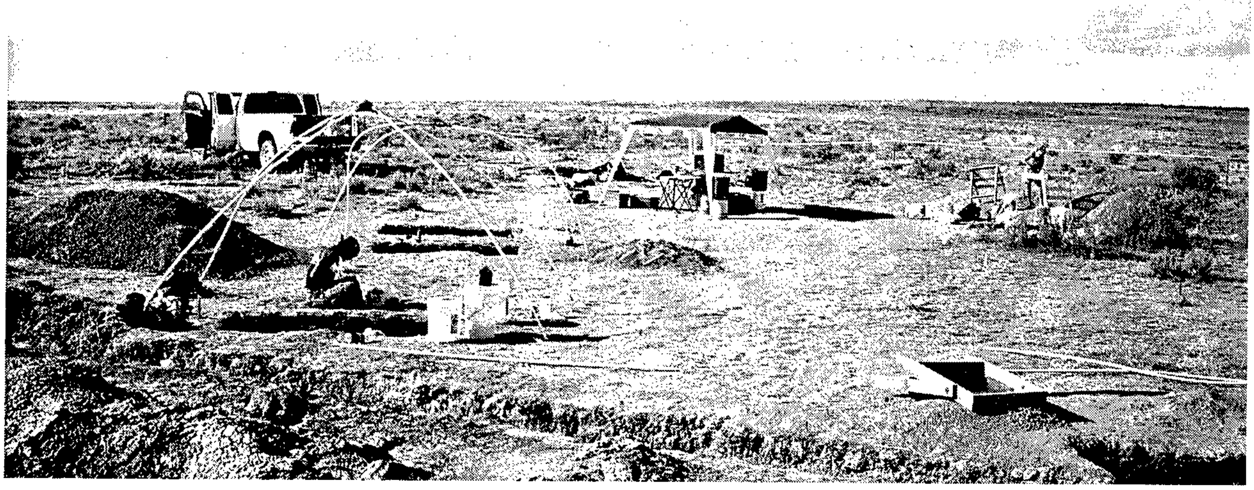

Figure 11. View to the south in the central site area showing Unit 1/2 (extreme lower right) and Units 5/6, 7/8, and 24/25 in near alignment to the left at the Barnes site, 5LA9187.

Six pairs of excavation units were placed within the known or probable extent of SP3 (Figure 5). Because this sediment package, like SP4, was a higher-energy alluvial deposit, we did not expect it to contain stable, horizontal living surfaces likely to have buried artifacts in association. If early artifacts occurred in the SP3 area, we expected them to be at or very near the present ground surface, effectively in the same horizon as the Late Prehistoric artifacts. Thus, we did not plan for many units in SP3 to penetrate more than two or three levels below

surface, depending of course, on how the stratigraphy panned out at any location. Units 7/8 were placed as near as possible to the original Folsom point find spot on the present surface, and they were designed foremost to sample and expose subsurface sediments in that immediate area. When excavation began there, we did not know if this unit pair fell within SP3 or SP2, and we did not know what to expect regarding the presence of the gray unit or depth of sediments in this location. Unit pairs 11/12 (Figure 12) and 13/14 were placed in locations where gravels were fairly abundant on the ground surface (in SP4?) and in places high enough on the local landscape that we were confident that preservation of the gray unit was not likely. These units were also placed within the densest part of the surface scatter of Late Prehistoric artifacts and were intended to sample that component and at the same time possibly collect some near-surface early artifacts. Units 19/20 were near the northeastern margin of the scatter of Late Prehistoric artifacts, and were intended to expose deeper sediments in a part of the site where age of deposits exposed in the nearby backhoe trench was unclear.

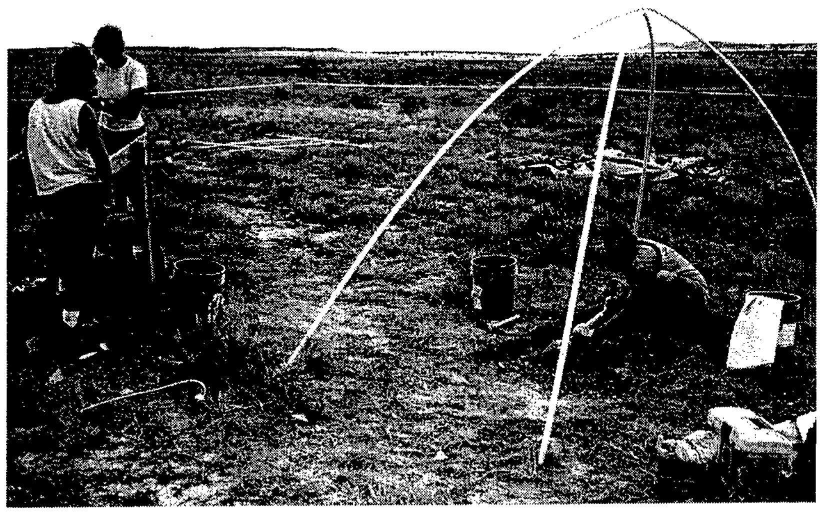

Figure 12. Kimberly Henderson, Jennifer Hudson, and Keith Hahn (l-r) excavating Units 11/12 at the Barnes site.

Two additional unit pairs were added within SP3 (24/25 and 26/27, Figure 5), specifically to provide greater coverage and possibility of finding Folsom age artifacts near the original Folsom find. When Jack Hofman joined the project, he noted that the Folsom point was made of Flattop chalcedony (White River Group silicate). This was noted to be a fairly uncommon stone type in the surface collection as a whole, yet a few additional Flattop tools and flakes occurred in the immediate vicinity of the original Folsom find. Hence, we felt that these additional units might retrieve more Folsom artifacts near the original find spot, and might also confirm a possible link between Folsom and a high incidence of Flattop chalcedony on the site.

A trio of whole or partial 1 x 1 m squares, Units 21, 22, and 23 and a small corner of a square that adjoined all of these and was later numbered Unit 40, were laid out on the southwest edge of Trench 4A to expose and sample near the pit feature (Feature 5) that had been discovered in the walls of the trench (Figure 5). These units were intended for shallow excavation only, targeting the Late Prehistoric age component in that area. As soon as the outline of the pit became apparent, excavation here shifted completely to removal of the pit. The fill of Feature 5 was processed completely by waterscreening. Field worker Roche Lindsey (Figure 13) took on what proved to be an arduous job of exposing, documenting, and removing the large number of tiny stone beads and other artifacts that occurred in the pit. What was initially considered to be a few-day effort lasted through both nine-day excavation sessions. The process of excavating this pit has been reported elsewhere by Lindsey (2001).

All of the eight remaining, numbered 1 x 1 m units or portions of units were related to the excavation of Feature 10, a hearth that was discovered deep within the southwest wall of backhoe Trench 1C (Figure 5). Backhoe work was planned to remove overburden from an area above and around the hearth, and prior to such removal Units 28/29 were excavated to shallow depth to sample the near-surface deposits in that area. Following the backhoe work, a several square-meter area had opened and leveled to a surface just a few centimeters above the elevation of the hearth (Figure 14). One unit pair, 30/31, was excavated to expose and remove the hearth (F10) and sediments a short depth beneath it, and four other whole or partial adjacent units (34, 35, 38, and 39) were opened to sample a modest area immediately around and on the same elevation as the hearth.

Figure 13. Roche Lindsey beginning the excavation of Feature 5, a Late Prehistoric pit bisected by Trench 4A at the Barnes site, 5LA9187.

Summary

Fieldwork related to the Late Prehistoric component at the Barnes site was a substantial success. A large and spatially well-controlled surface collection comprised of more than 700 items, most probably being Late Prehistoric in age, was documented and awaits analysis. There is a great deal of raw material variability within the collection, and a large percentage of the lithic artifacts are heat-altered (reflecting hearth-related activity). The potential for settlement pattern analysis and study of site function is very high, based on this large and varied artifact sample.

Figure 14. Michael Chidley, Ardeth Vineyard, and Keith Hahn excavating in the Feature 10 area near Trench 1C at the Barnes site, 5LA9187.

Excavations revealed shallow and spatially variable Late Prehistoric artifacts in many XU locations. Specific results of hand excavations will be discussed in greater detail in Chapter 6. Outside of features, artifacts occurred in relatively low densities. Based on field observations, it

was thought that the count of pottery sherds from excavation might exceed the count of flakes and stone tools from excavation (excluding Feature 5, the large pit). Remnants of three near-surface hearths were encountered in excavation (Table 1). The occurrence of three hearths in a total of perhaps 14 m^2 of testing in the central part of the Late Prehistoric component indicates that hearth features probably exist at the site in high numbers. The test excavations, in combination with surface artifact data, are sufficient for accurately demarcating the part of the site where Late Prehistoric artifacts and features can be found in highest density.

One enigma regarding the Late Prehistoric component at the Barnes site is the near absence of animal bone in the excavated collection. No bone was observed on the surface. One highly eroded complete femur of a rabbit or similar-sized animal was observed in the upper part of Feature 5. The remainder of this pit and all other excavations in late contexts produced a total of two or three fragments of highly calcined bone that were observed during fieldwork. Based on field observations, unburned bones or even tooth enamel fragments of antelope or bison-sized animals were missing from the excavated samples. This is despite a chipped stone artifact assemblage that indicates a clear focus on hunting, hide preparation, and repair of weaponry. By the close of fieldwork, we were speculating that some aspect of soil chemistry was highly deleterious regarding bone preservation.

As will be detailed in Chapters 5 and 6, the work in deeper contexts in search of Paleoindian age or any other buried components was informative but far less productive in terms of artifact return. Disappointedly few artifacts were found in association with Feature 10, the deeply buried hearth. We left the field not knowing the age of the hearth, nor understanding the age of the underlying gray unit. By the close of fieldwork, we had demonstrated the paucity of artifacts on the upper surface of the gray unit, and we also knew that it was a scoured off B soil horizon rather than an A horizon, as thought in 2000. It nevertheless contained a lot of dateable charcoal, and we were optimistic that it might be Pleistocene in age, providing at least substantial time depth and greater potential for paleoenvironmental information in the data from excavation. It was with these thoughts that we left the field, developed a strategy for radiocarbon dating and soils analysis, and entered the lab phase of the project.

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3. LABORATORY WORK AND METHODS

Stanley A. Ahler

Two components of lab work were conducted as part of this study. One involved special analyses performed by persons outside either the PCRG lab in Flagstaff or Dave Kuehn's lab in El Paso. These studies involved review of available samples to be analyzed by other parties and related coordination regarding sample submittals and determination of results. This component of lab work began immediately after the close of fieldwork for certain types of analyses.

The second component of lab wok involved in-house investigations conducted by PCRG staff in Flagstaff and by Dave Kuehn. Dave explains in detail in Chapter 4 the analyses and determinations related to soil and sediment samples that he conducted himself. In the second section in this chapter, I provide details about samples, methods, and procedures pertinent to the PCRG lab.

Special Sample Selection and Analyses

The immediate concern regarding outside analyses was in the realm of radiocarbon dating of various stratigraphic contexts at the site. When we left the field we had identified one buried component within the site, represented by hearth activity at Feature 10, but we had no clear understanding of the age of this cultural unit. Estimations of the age of Feature 10 offered by field crew members at the end of the season ranged from mid-Holocene to Late Pleistocene, with the greatest concentration of estimates coincident with accepted ages for Folsom culture (between 10,000 and 11,000 BP). Before we departed the field, we submitted a single charcoal sample from F10 (Cat. No. 1368) to Beta Analytic for rapid AMS dating.

In the lab, we immediately reviewed all other plotted charcoal samples with good provenience and in deep contexts. Table 2 provides a list of available samples. Charcoal in association with Feature 10 was abundant, but we had far fewer choices regarding samples from the gray unit or the immediately overlying brown unit in various parts of the site. Several additional non-plotted charcoal pieces had been collected by excavators and screeners from some of the hand excavations that penetrated the gray unit, but we were hesitant to use these in the absence of precise contextual information.

Following discussions with Larry Loendorf, we decided to submit eleven samples, in addition to the single sample from F10 already in progress at Beta Analytic, to Herbert Haas of RC Consultants, Inc. for pretreatment by him and AMS dating at the ETH facility in Switzerland. One sample was to be submitted from Feature 5 (Late Prehistoric pit), with 10 samples coming from deep stratigraphic contexts including two additional samples from Feature 10. Contents of each sample container from deep contexts other than Feature 10 were examined in detail by Ahler for isolation of the actual charcoal piece. In a few instances, as indicated in Table 2, no actual charcoal could be found. In some other instances, the available charcoal material was

Table 2. Information regarding context of all plotted charcoal samples from deep contexts available for AMS dating as well as some samples in late contexts. Samples submitted for pretreatment and dating are shaded; darker shading indicates dated samples.

Trench or XU	Gen Lev No	Cat No	Feat. No.	N Coord	E Coord	Elev.	Status of Sample
Backhoe Trench Profiles							
BHT-1A	sample A	1519		1002.66	1010.85	998.81	Charcoal could not be found
BHT-1A	sample B	1520		1003.31	1011.95	998.81	Sub-marginal size; not submitted
BHT-1A	sample C	1521		1003.32	1011.96	999.09	Barnes # 6; too small to pretreat
BHT-1A	sample D	1522		1002.80	1011.93	999.57	Barnes # 7; too small to pretreat
BHT-1B	sample A	1516		996.10	1022.25	999.17	Barnes # 5; dated
BHT-1C	sample A	1512		986.00	1038.03	999.39	Barnes # 4; partial pretr.; dated
BHT-1C	sample B	1513		985.56	1038.78	999.48	Barnes # 12; too small to date
BHT-1C	sample C	1514		985.63	1038.70	999.78	Barnes # 3; dated
BHT-1C	sample D	1515		985.47	1039.59	999.58	Strat. unit association unclear
BHT-4A	sample A	1510		987.47	988.96	998.89	Charcoal could not be found
BHT-4A	sample B	1511		986.97	989.94	999.56	Barnes # 8; dated
Samples Assoc. w/ F10							
BHT-1C		1221	10	989.50	1038.20	999.70	Dateable, redundant
BHT-1C		1292		990.00	1038.50	999.24	Dateable, redundant
30	2	1298		989.38	1038.07	999.80	Dateable, redundant
30	3	1313		989.41	1038.26	999.75	Dateable, redundant
30	3	1314		989.39	1038.25	999.74	Dateable, redundant
30	3	1323		989.36	1038.23	999.73	Dateable, redundant
30	3	1324		989.52	1038.36	999.73	Dateable, redundant
30	3	1325		989.53	1038.08	999.74	Dateable, redundant
30	4	1368	10	989.69	1038.15	999.68	Barnes # 0, # 1; dated
30	4	1365	10	989.52	1038.22	999.70	Dateable, redundant
30	4	1364	10	989.52	1038.08	999.70	Dateable, redundant
30	4	1366	10	989.60	1038.14	999.67	Dateable, redundant
30	4	1367	10	989.68	1038.06	999.68	Dateable, redundant
31	1	1299		989.98	1037.23	999.91	Dateable, redundant
31	2	1305		989.84	1037.62	999.90	Dateable, redundant
31	2	1306		989.67	1037.75	999.90	Dateable, redundant
31	3	1347		989.75	1037.98	999.72	Barnes # 2; dated
31	3	1348		989.74	1037.98	999.73	Dateable, redundant
Other Deep Test Units							
3	11	1242		1012.66	1006.31	998.81	Dateable sample
5	9	1504		1002.70	1010.72	999.30	Dateable, redundant
5	9	1505		1002.91	1010.81	999.30	Barnes # 13; dated
5	9	1478		1002.30	1008.55	999.36	Marginal sample size
7	10	1492		996.01	1009.87	999.50	Barnes # 9; dated, marginal size
Late Contexts							
22	3	1661	5	988.99	987.99	998.97	Barnes # 11; dated
26	1	1186	8	994.50	1013.17	1000.45	Barnes # 10; marginal size; replace w/ Barnes # 14 Feat. 8 float.
26	1	1187	8	994.30	1013.31	1000.45	Dateable sample

extremely small. The ten most suitable samples from deep contexts were submitted to Herbert Haas for his examination. He conducted sample cleaning and preparation work and concluded that some of the submitted samples had too little material for dating. In order to bring the count of samples prepared by Haas back up to 11, I then submitted virtually all of the available sample materials from all deep locations with good association and control, as well as one additional sample from Feature 8, a probable Late Prehistoric hearth. Herbert prepared and submitted the 11 best samples to the AMS facility.

Ultimately, the ETH lab dated ten of the 11 submitted samples, and Beta Analytic dated the single sample from Feature 10. Briefly, the results indicate that all sediments penetrated by trenches and excavations in the site are younger than 8100 BP in age, that Feature 10 dates circa 6800-7000 BP, and that the Late Prehistoric component dates to about 700 BP. Because the single date received from Beta on Feature 10 and eight of the ten dates generated by ETH deal with buried contexts and are primarily of geologic significance, detailed dating results are presented and discussed by Dave Kuehn in Chapter 4.

Samples were systematically collected in the field from two column locations for purposes of special sediment studies and pollen/phytolith analysis. One column involved a series of 11 samples representing all stratigraphic units in the wall of backhoe Trench 1C (Cat. Nos. 1519A-K), and the second was a series of eight samples from the west wall of excavation Unit 2 (Cat. Nos. 1526A-H). Pollen/phytolith studies were deferred until radiocarbon dates were available; when it was learned that no Pleistocene age sediment was represented in the samples, the decision was made not to pursue pollen and phytolith analyses. Spare sample material has been archived should such studies be appropriate in the future. Based on recommendations from Dave Kuehn, the decision was made to have organic carbon percentage and stable carbon isotope ratio determinations made for a subset of samples in the two columns. Funding was available for analyses of 10 samples. Emphasis was placed on the column in Trench 1C that was more fully described, deeper, and better dated. Eight samples were selected from that column for analysis, and two from the column in Unit 2. In Chapter 4, Dave Kuehn discusses additional details of sample submittal as well as results.

Steve De Vore collected columns of sediment for magnetic susceptibility tests from one location in the west wall of excavation Unit 2 and from another location in the northeast wall of Trench 1A. Sample locations are illustrated in Figure 15 (Chapter 4) and Figure 21 (Chapter 6). Steve has written a separate report (2002) detailing the results of the magnetic susceptibility studies, included as Appendix B, herein.

Methods for Sorting and Quantifying Excavated Collections

The surface collections were rebagged in consistently labeled plastic bags and were organized according to general artifact size and type for purposes of boxing and retrieval. All items in the extant collection had previously been classified or assigned by Mark Owens to an artifact class with a certain level of specificity. The surface artifacts were not reclassified for the purposes of this study, which did not focus on analysis of late component artifacts. Specific items in the surface collection that had been previously identified as certain or possible Paleoindian age artifacts were examined in detail, as discussed in Chapter 5.

Excavated collections from all contexts and retrieved by all methods of recovery were systematically processed, sorted, and quantified. For purposes of collection organization, we first divided excavated samples into two subsets based on context: (1) those from deep contexts (from general level 4 or deeper in all excavation units that started at the surface, and materials from all levels for Units 30, 31, 34, 35, 38, and 39 in the Feature 10 area), intended to capture any potential Archaic or Paleoindian age cultural materials, and (2) those from shallow contexts (general levels 1-3 from all units starting at the surface), intended to capture Late Prehistoric component artifacts. As noted in Chapter 2, all samples from Feature 5 and the nearby excavation squares (Units 21, 22, 23, 40) were segregated in the field and were studied elsewhere. An exception to this involved one bulk sediment flotation sample and one archived sediment sample from within Feature 5 included with the material in Flagstaff.

Within each of these contextual subsets, there existed samples collected by quarter-inch dryscreen, by 16-per-inch mesh waterscreen, by three-dimensional plotting, and by collection in bulk for purposes of flotation. The first step in processing screened excavated samples was flotation, if such was deemed necessary. Only waterscreened samples from late contexts were floated, as this was done simply to remove the light fraction prior to sorting. The light fraction in this case consisted predominantly of recent uncharred root and other plant material, and this was discarded after flotation. All waterscreened, dryscreened, and plotted samples from all contexts were next size-graded over a series of nested square-mesh screens made of U. S. Standard Sieve Cloth with the following size grade designations and opening sizes: G1 = 1.000 in; G2 = 0.500 in; G3 = 0.223 in; G4 = 0.100 in; and G5 = 0.046 in. For dryscreened samples, this yielded material in G1, G2, G3, and what we called <G3, or material inadvertently collected that was smaller than G3 size (G3 is approximately the same as quarter-inch field screen opening size). For waterscreened samples, we retained materials in G1, G2, G3, G4, and G5 screens and discarded materials < G5 in size. For bulk float samples (all from feature contexts) we first archived a ca. 1 kg sample of sediment for purposes of future study (pollen, phytolith, particle size, etc.), then we weighed the balance of the sediment, floated it in water over 0.5 mm mesh screen, dried each fraction, and size-graded the heavy fraction into G1 - <G5 size fractions. Floated bulk matrix weights are as follows for various contexts: F7 (Cat. No. 1133) 1.40 kg; F5 (Cat. no. 1185) 5.01 kg; F8 (Cat. No. 1188) 10.42 kg; F9 (Cat. No. 1189) 0.48 kg; F8 (Cat. No. 1246) ~9.25 kg; F10 (Cat. No. 1353) 6.38 kg.

After floating (if applied) and size-grading, we sorted all samples according to a standard set of protocols. Table 3 provides the sorting classification list and protocol for dryscreened samples, and Table 4 provides a similar protocol for waterscreened, floated, and plotted samples and artifacts. The sorting protocol varied slightly according to the type of recovery (dryscreen vs. waterscreen or flotation) and in some cases according to context (deep versus late). These differences are indicated in the two tables and in notes to Table 4. A few sorting categories and sorting decisions were developed specifically for this project, due to its particular content. Because we were particularly interested in recovering any cultural material from all contexts, we sorted all possible cultural materials from the <G3 size materials from the dryscreen samples (<G3 is often ignored or discarded on most projects). Because bone appeared to be degraded or absent from many contexts in the site, we sorted all bone of any kind (identifiable or unidentifiable) from all available samples in all sizes. We wished to document the presence, size, and condition (burned or unburned) of bone whenever it occurred. We noticed the presence of pedogenic carbonate nodules in several deep context samples, in sizes as large as G2 and in

certain locations. We thought that the presence and abundance of such carbonates might provide data useful for interpretation of soils and geology. Consequently, we sorted pedogenic carbonates selectively from sizes G1-G4 in the deepest excavation units (Units 1-4) that provided potentially the deepest stratigraphic sequences in the site and in G1-G3 in all other contexts.

Table 3. Sorting procedures for dryscreened samples, also showing the quantification data for each class entered in the project database for the Barnes site, 5LA9187.

Class / Subclass	Size Grade Sorted From				Quantification Data
	G1	G2	G3	<G3	
Pottery	X	X	X	X	
Rim/Lip	X	X	X	X	n & wt by size
Body Shreds	X	X	X	X	n & wt by size
Fire-Cracked Rock	X	X	X	X	n & wt by size
Natural Rock	X	X	X		wt by size
Burned Earth	X	X	X		n & wt by size
Pedogenic Carbonate	X	X	X		wt by size
Modified Stone	X	X	X	X	
Stone Tools	X	X	X	X	n & wt by size
Flaking Debris	X	X	X	X	n & wt by size
Ochre / Pigment	X	X	X		n & wt by size
Charcoal	X	X	X	X	presence/absence by size
Charred Seeds / Botanicals	X	X	X	X	n by size
Bone	X	X	X	X	
Unburned Bone	X	X	X	X	n & wt by size
Burned bone	X	X	X	X	n & wt by size
Shell	X	X	X		
Fossil Shell	X	X	X		presence/absence by size
Nonfossil Snails	X	X	X		presence/absence by size
Unsorted Residue				X	weight

We noted two kinds of shell as being abundant in the screened samples. One was fragments of bivalve shell, presumably fossils, which apparently derived from the bedrock in the site catchment area. The second was non-fossil terrestrial gastropods or snails. Snails were abundant in many samples from many different depths within the site. We considered snails to be important potential sources of paleoenvironmental information. We therefore sorted all shell (fossil and gastropods) from all size grades in selective excavation units (Units 1-4) that provided a deep stratigraphic sequence from near Trench 1A, and from the six units excavated over and around the deeply buried Feature 10. The sorted snails were not analyzed for this project, but are available for future research.

A few classes of artifacts or materials have only two or three occurrences in the collections. Two pieces of possible red ochre or pigment occurs in the collection; these may simply be soft, burned, iron-rich natural pebbles. A single piece of what appeared to be anthracite coal was recognized and separated in the sorting process. A single tiny (G5) glass bead was plotted after it was noticed on the floor of a deep excavation level, well into mid or early Holocene age sediments. Field workers thought the bead probably fell onto the floor of the unit from the surrounding surface. This artifact was recorded and kept in the site collection.

Table 4. Sorting procedures for waterscreened, flotation heavy fraction, and plotted samples, also showing the quantification data for each class entered in the project database for the Barnes site, 5LA9187.

Class / Subclass	Size Grade Sorted From					Quantification Data
	G1	G2	G3	G4	G5	
Pottery	X	X	X			
Rim/Lip	X	X	X			n & wt by size
Body Shreds	X	X	X			n & wt by size
Fire-Cracked Rock	X	X	X			n & wt by size
Natural Rock[C]	X	X	X			wt by size
Sedimentary[C]	X	X	X			wt by size
Non-Sedimentary[C]	X	X	X			wt by size
Burned Earth	X	X	X			n & wt by size
Pedogenic Carbonate[A]	X	X	X	X[A]		wt by size
Modified Stone	X	X	X	X		
Stone Tools	X	X	X	X		n & wt by size
Flaking Debris	X	X	X	X		n & wt by size
Ochre / Pigment	X	X	X	X		n & wt by size
Charcoal	X	X	X	X	X	presence/absence by size
Charred Seeds / Botanicals	X	X	X	X	X	n by size
Bone	X	X	X	X	X	
Unburned Bone	X	X	X	X	X	n & wt by size
Burned bone	X	X	X	X	X	n & wt by size
Shell[B]	X	X	X	X[B]	X[B]	
Fossil Shell	X	X	X	X[B]	X[B]	presence/absence by size
Nonfossil Snails	X	X	X	X[B]	X[B]	presence/absence by size
Mineral (Coal)	X	X	X	X	X	n & wt by size
Glass Bead				X	X	n & wt by size
Organic (Seed Bead)				X	X	n & wt by size
Unsorted Residue				X	X	wt by size

Notes: A – Pedogenic carbonate was consistently sorted from G4 size only from excavation Units 1, 2, 3, and 4.
B – Fossil shell and nonfossil gastropods were consistently sorted from G4 and G5 sizes only from Units 1, 2, 3, 4, 30, 31, 34, 35, 38, and 39.
C – Separation of natural rock into sedimentary lithologies and non-sedimentary lithologies occurred only for waterscreened samples from deep contexts.

Several organic beads were sorted from the float sample for Feature 5, and a category was created for these specimens. There were many recent, uncharred seeds and other botanical specimens in the collections. We only saved ones that appeared to be charred, and these included a number of apparently calcined hackberry seed fragments from several contexts. Other artifact classes often seen in Late Prehistoric collections such as fired clay were searched for but were not found in the Barnes site samples.

Following the process of sorting, routine procedures for quantification of the sorted material were applied to all samples. We recorded some combination of count, weight, or presence/absence information by size grade for different artifact and material classes. The specific data type recorded for each class is indicated in Table 3 and Table 4. These data were entered in relevant tables in the project database that was created in Microsoft Access (Office 97

version). The database as developed and transferred to project participants at the completion of this phase of work contains three data tables. One table called "Catalog&Processing" contains virtually all information regarding provenience, recovery methods, etc., entered directly from the field catalog. A second table called "ResidueNatRock" contains weight data for natural rock, pedogenic carbonate, and unsorted residue classes from all contexts. A third table called "GenQuantifTable" contains all count, weight and/or presence/absence data for all of the other artifact and material classes listed in Tables 3 and 4.

The three database tables just noted were linked and used to generate vertical and horizontal distribution information for various classes of artifacts. Pedogenic carbonate data were summarized and sent to Dave Kuehn for his use in Chapter 4. More complex or sophisticated data analyses and data sets were not developed for the project. Artifacts in deeper contexts that are treated in detail in the current report were relatively sparse and are discussed and described on an individual specimen basis in Chapters 5 and 6.

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4. TRENCH INVESTIGATIONS: SOILS AND STRATIGRAPHY

David D. Kuehn[6]

Introduction

In July and August 2001, stratigraphic and pedologic investigations were conducted at archaeological site 5LA9187, Pinon Canyon Maneuver Site (PCMS), southeastern Colorado. The investigations were conducted by the author under a subagreement with PaleoCultural Research Group (PCRG), Flagstaff, Arizona, for the purpose of augmenting archaeological excavations at the site. The geoarchaeological research focused on the description and interpretation of soils and sediments exposed within four major backhoe trenches excavated at various locations throughout the site.

Laboratory analyses included the determination of soil texture, stable carbon isotope values, and soil organic carbon content. These data, together with descriptive information gathered in the field, are examined within a temporal context provided by a series of AMS radiocarbon ages. Together with the temporal data, the physical and morphological characteristics of soils and sediments at 5LA9187 enable the elucidation of a basic geochronologic framework for the archaeological investigations.

This chapter summarizes the geoarchaeological research at 5LA9187 and is organized into four topical subsections: (1) the physiographic and geologic context of site 5LA9187; (2) goals of the 2001 research effort; (3) field and laboratory methods; and (4) project results and interpretations.

Physiographic and Geologic Setting

Site 5LA9187 is located ca. 65 km northeast of Trinidad, Colorado, in the Raton section of the Great Plains physiographic province (Trimble 1980, 1990:24; Fenneman 1931). The Raton section marks a transition between the Front Range of the Rocky Mountains and the High Plains. The section is bordered on the north by the Arkansas River and the Colorado Piedmont section of the Great Plains, and on the south by the Canadian River and the Pecos Valley section (Trimble 1990:10). All three sections represent the western limits of the Great Plains province (Trimble 1990).

The Raton Basin is the predominate physiographic and structural feature within the Raton section. The Raton Basin is a relatively small Cretaceous, and possibly late Mesozoic, depression filled with sedimentary rocks and volcanic intrusives (Trimble 1990:24-25). The basin extends from the tilted sedimentary "hogback" ridges at the front of the Rocky Mountains, east to the High Plains. The section has been traditionally noted for its volcanic dykes, vents, and lava-flows, which are Tertiary in age. These features are concentrated in the vicinity of Raton Mesa and Mesa de Maya to the south of PCMS, and in the Spanish Peaks area to the southwest (Trimble 1990:10, 23-24). Mapped igneous rocks in these areas include Tertiary

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intermediate to felsic intrusive and Tertiary basalt flows (Tweto 1979). In the Trinidad Mesa and Mesa de Maya areas, the igneous rocks are underlain by the gravelly Ogallala Formation of Tertiary age (Trimble 1990; Tweto 1979). In other portions of the section, the Ogallala is absent (erosionally truncated), and the volcanic rocks are underlain by the shale and limestone beds of the Cretaceous Niobrara Formation (Trimble 1990).

In non-volcanic portions of the Raton section, which include site 5LA9187, the topography is dominated by hilly to low relief grasslands, pinyon-juniper slopes, stream valleys, gullies, and "hogback" ridges constructed of shale, sandstone, and limestone (Tweto 1989). In the PCMS these rocks are Cretaceous in age and include (from Trimble 1990 and Tweto 1989): the Niobrara Formation (calcareous shale and limestone), Carlyle Shale, Greenhorn Limestone, Graneros Shale, Dakota Sandstone, and the Purgatoire Formation (sandstone and shale).

Site 5LA9187 is located near the upper end of the Lockwood Arroyo drainage basin, on an unnamed tributary to Lockwood Arroyo, in the north-central portion of PCMS. Lockwood Arroyo and this tributary are ephemeral, moderately meandering streams that head in Niobrara Formation uplands several km northwest of 5LA9187 and empty into the Purgatoire River approximately 12 km to the southeast. Bedrock in the 5LA9187 site area is mapped simply as "Carlyle Shale-Greenhorn Limestone-Graneros Shale" (Tweto 1989). Outcrops of highly weathered shale are extant within 25 – 100 m of the site. A sample of one such outcrop was collected and analyzed for elemental composition at the Texas A&M University Scanning Electron Microprobe Laboratory. The results of this analysis have not yet been received.

Dakota Sandstone, which underlies the Carlyle Shale-Greenhorn Limestone- Graneros Shale material, is visible along the margins of the arroyo a short distance downstream from 5LA9187 (ca. 300 – 500 meters). Vertical exposures of Dakota Sandstone are common along the unnamed arroyo downstream from this point.

Prehistoric artifacts at 5LA9187 were situated on, and below the surface of, two Holocene depositional terraces. These are extant along the south/southwestern side of the arroyo channel (see Figures 4 and 5, Chapter 2). Most of the artifacts were collected from the tread of the higher T2 terrace, which rises ca. 1.7 – 2.2 m above the floor of the current channel. The surface of the T1 tread is ca. 1.10 – 1.6 m above the modern channel floor. The riser between the two terrace surfaces is visible, but not markedly so (i.e., a .60 m rise over a linear distance of ca. 5.5 m). Portions of both the T1 and T2 terrace fills have been impacted in places by small gullies, which have cut channels roughly perpendicular to the long axis of the arroyo channel (see Figure 1, Chapter 2).

Research Objectives

The geoarchaeological investigations at 5LA9187 were undertaken as part of a larger program of archaeological field investigations conducted by PaleoCultural Research Group in July and August 2001. The primary goal of the geoarchaeological research therefore, was to recover information that could be used as an adjunct to the archaeological investigations, particularly information relevant to the age, spatial/temporal distribution, integrity, and natural history of extant cultural materials (cf. Schiffer 1987:15-21). These basic constituents of archaeological research encompass what Gladfelter (1981), Hassan (1979), Waters (1992), and

others, have identified as the principal objectives, or "study components" of contemporary geoarchaeology (Butzer 1982:35). These include: (1) sedimentological context – the physical characteristics of the site matrix and the depositional sedimentary environments responsible for their aggradation; (2) temporal context -- the chronological sequence of terrace-fill deposition, erosion, and landscape stability in the site area; and (3) stratigraphic context -- the physical and temporal relationships between individual stratigraphic units. The geoarchaeological investigations at 5LA9187 focused on the recovery of information relevant to the understanding of these three research domains. The concepts and methods behind their interpretation are firmly grounded in the geosciences (Waters 1992:7-12).

Determining the age of archaeological materials has long been a cooperative effort between archaeologists and geoscientists and needs little reiteration here (cf. Rapp and Hill 1998:153). At site 5LA9187, the question of temporal context was addressed through the procurement of one standard and 11 accelerator mass spectrometry (AMS) radiocarbon dates. Recovered from cultural features and charcoal scattered throughout the site matrix, these age determinations indicate that cultural activity or occupation at 5LA9187 took place over a span of ca. 6900 years. The ^{14}C data also enabled the establishment of a chronological framework for interpretation of the geologic history of the site area, which, in this report, will be presented in the form of limited geochronologic reconstruction. Key to this reconstruction is the identification and timing of changes in the local landscape. For example, at any given point in time, any particular landscape or land surface is in one of three geomorphic modes: (1) stability; (2) erosion; and (3) deposition (Waters 1992:91). Geoscientists recognize these landform conditions in the geologic record through stratigraphic characteristics. During periods of landscape stability, surface sediments are subjected to weathering, plant growth, the accumulation of organic matter, human and animal activity, etc. (Waters 1992). These processes result in the formation of soils, visible in the subsurface as paleosols, or buried soils, and on the surface by modern or relict soils (Birkeland 1984; Waters 1992). Paleosols indicate episodes of past landscape stability. Periods when landscapes have undergone depositional events are recognized by the presence of stratigraphic units; vertically stacked packages of sediment associated with specific episodes and modes of deposition (Boggs 1987; Krumbein and Sloss 1963). Episodes of landscape erosion are recognizable on the basis of concave or highly irregular boundaries, or unit contacts, and by the partial or complete truncation of stratigraphic units and soils (Boggs 1987). In arid and semi-arid environments, erosional events are also represented by deflation surfaces. An important goal of the research at 5LA9187 is to identify the sequence and timing of these types of landscape changes.

The interpretation of sedimentological context at 5LA9187 included analysis of the physical characteristics of sediments and soils, and the identification of sedimentary depositional environments. The latter are responsible for the aggradation of the terrace fill deposits associated with the cultural materials at site 5LA9187. The investigative procedures employed are a major component of sedimentology, the geologic discipline concerned with the classification, origin, and interpretation of sediments (Bates and Jackson 1980; Boggs 1987). They also include pedology, the scientific study of soils (Birkeland 1984; Soil Survey Staff 1990). The physical characteristics selected for study include grain size (texture), color, sedimentary structure, soil development and soil horizon morphology, unit or soil boundaries, and contact distinctness and topography (cf. Boggs 1987; Waters 1992; Holliday 1992; Soil Survey Staff 1951).

Depositional sedimentary environments include those dynamic processes and static elements of any particular landscape that are responsible for the production, transportation, and deposition of identifiable bodies of sediment (Boggs 1987:305-320). These bodies of sediment have distinctive sets of physical, chemical, and stratigraphic characteristics (Boggs 1987:306; Reineck and Singh 1980). By recognizing these characteristics, particularly lithology, grain size, sorting, and primary sedimentary structure, the investigator can identify under which type of environment a body of sediment was deposited (normally some form of alluvial, fluvial, eolian, colluvial, lacustrine, or marine). The dominant depositional environment at 5LA9187 is that of a stream floodplain characterized by repeated overbank flooding and sediment aggradation, or vertical accretion (cf. Boggs 1987:354-360; Brakenridge 1987; Allen 1971). Within any active landscape, it is likely that a number of bodies of sediment with different physical, chemical, and stratigraphic characteristics were deposited synchronously. Representing additional depositional environments, these contemporaneous bodies of sediment are termed "facies" (Boggs 1987:306; Waters 1992:38). At site 5LA9187, floodplain/overbank facies are the most widespread, but others, particularly channel lag deposits, have also been identified. Yet others, such as near-channel natural levee and crevasse splay facies, have been preserved in the terrace fill sediments, but are rare and hard to identify.

Stratigraphy, the study of vertical and lateral relationships between sediments based on lithologic, chronologic, and other characteristics (Boggs 1987:522; Krumbein and Sloss 1963), is a key element in the geoarchaeological investigations. The basic element of stratigraphic investigation is the stratigraphic unit, a body of sediment compositionally, texturally, or structurally distinguishable from adjacent, overlying or underlying units (Boggs 1987; NACOSN 1983; Waters 1992). Stratigraphic units are often deposited during a single recognizable episode of deposition under a consistent depositional environment (cf. Otto 1938; Waters 1992:34). As previously stated, bodies of sediment deposited under specific depositional environments often contain physical, chemical, and/or stratigraphic properties that are characteristic of that environment (Boggs 1987; Waters 1992). If these properties are purely textural and/or structural, the frequently tabular or lenticular bodies of sediment are termed "lithostratigraphic units" (Boggs 1987:523; Waters 1992:62). Other criteria applied to the identification and analysis of stratigraphic units include biologic, pedologic, magnetic, and chronologic (NACOSN 1983; Boggs 1987). Organizing units based on lithology is the most common form of stratigraphic analysis in geoarchaeology (Waters 1992:62-63), and is the basic unit of analysis at 5LA9187.

Correlation, demonstrated physical and temporal equivalency among various stratigraphic units (Boggs 1987), was an important initial goal of the geoarchaeological investigations. This task proved difficult to realize due to rodent disturbance, post-depositional erosion, homogeneity in unit texture and color, the obliteration of sedimentary structure by pedogenesis, and a general paucity of stratigraphically sensitive radiocarbon ages. Consequently, while interpretations of stratigraphic unit similarity are presented, these are considered tentative.

Field and Laboratory Activities and Methods

The 2001 geoarchaeological research efforts at 5LA9187 were preceded by preliminary stratigraphic investigations conducted by the author in September 2000. The investigations were undertaken in order to examine the stratigraphic context of subsurface deposits at the site and to investigate the possibility of buried archaeological materials, particularly those that may have been formerly associated with a Folsom projectile point that was found on the surface of the site during the original survey. The initial field research centered on the excavation and stratigraphic interpretation of two backhoe trenches placed along an alignment close to where the Folsom projectile point was originally located earlier in 2000. The first trench, Trench A, extended from the modern channel in the arroyo, southeast for a distance of ca. 26 m. The second trench, Trench B, was located ca. 20 m southeast of Trench A and had a length of 4 m. Trench locations and the Folsom point find spot are shown in Figure 5, Chapter 2.

The initial trenching demonstrated that site 5LA9187 was associated with two terrace fill remnants (T1 and T2), which were demarcated on the surface by a low-angle scarp and in the subsurface by an alluvial cut-and-fill contact. The latter was visible near the southeastern end of Trench A. During the inspection of the initial backhoe trench profiles, several artifacts were recovered from the top of a buried soil in the T2 fill at a depth of 0.94 m below the surface[7] (this discovery location is shown in Figure 5, Chapter 2). During the 2001 field effort, this paleosol was designated as the S2 soil in Trench 1A and consists of a carbonate-rich Bkb2 horizon. Both this soil and its possible spatial distribution within the site area are discussed in more detail in the subsequent section of this report.

At the end of the 2000 fieldwork, a series of sediment and radiocarbon samples was collected from key sections within the T1 and T2 fills. Two of the radiocarbon samples were submitted for analysis but subsequently proved unsuitable. One sample comprised of bulk sediment collected from the unit overlying the S2 soil in Trench 1A produced an AMS age of 18,480±160 yr BP (Beta-152945). This age was incongruous with the expected age of the T2 terrace fill, which on the basis of local stratigraphic chronologies, was thought to date from the late Pleistocene through middle Holocene (cf. McFaul and Reider 1990). The second sample, collected from dark pond sediments at the bottom of the T1 fill, was determined during pretreatment to be decomposed shale rather than charcoal. Consequently, no substantive data on the age of the T1 and T2 sediments were available prior to the initiation of the 2001 investigations.

The 2001 field effort began with extension of the two trenches excavated in 2000. Together they formed what became designated as Trench 1, which was comprised of three segments. The first, Trench 1A, began near the contact between the T1 and T2 fills at the southeastern end of former Trench A and extended southeast across the T2 terrace fill for 32 m (Figure 5, Chapter 2). The second, Trench 1B, included all of Trench B and was 6 m in length (Figure 5, Chapter 2). The third, Trench 1C, was located furthest away from the modern channel and had a length of 6 m. Both Trench 1B and Trench 1C were extant within the T2 terrace fill although they proved to have remarkably different sedimentological composition.

[7] These artifacts and their context are discussed further in Chapter 5, herein. They have subsequently been evaluated as Late Prehistoric in age and intrusive from the surface component into a deep context via rodent burrows. -- SAA.

Three additional trenches were excavated subsequent to Trench 1. Trench 2 was placed in the southwestern portion of the site and was comprised of four segments (Trench 2A – Trench 2D), which had a combined length of 35 m (see Figure 4, Chapter 2). Trench 3 was located near the eastern edge of the site and consisted of a single 25.5 m long segment. Trench 4 was located northwest of Trench 1 in the central site area, and was a single segment ca. 27 m in length (Figure 5, Chapter 2). Discussion in Chapter 2 provides additional details regarding the rationale and decision-making processes surrounding location choices for the 2001 trenches.

The trench excavations were followed by cleaning and detailed recording of the exposed stratigraphic profiles (see Figures 6 and 7, Chapter 2) and by the recovery of constant volume sediment samples, sediment samples collected from principal stratigraphic units, and charcoal samples. The constant volume sample columns were located in excavation Unit 2 and Trench 1C, and were collected for stable carbon isotope and organic carbon analysis. Column locations are shown in Figure 15, below, and in Figure 20, Chapter 6.

The radiocarbon samples (wood charcoal) deemed most suitable for geochronological studies were collected by the author from walls of backhoe Trenches 1A, 1B, 1C, and 4A. A few additional charcoal samples were piece-plotted by archaeological crew members in deep locations during hand excavation. All samples available from deep contexts are identified in Table 2, Chapter 3, and the process of selecting samples for pretreatment and radiocarbon analysis is also described in that chapter. As discussed there, several of the collected samples were not sent for radiocarbon analyses because of insufficient sample sizes, unclear stratigraphic context, or redundancy (sufficient numbers of better samples were already available from that stratigraphic unit or archaeological feature). One AMS sample was submitted to the Beta Analytic laboratory before the completion of fieldwork, in order to gain a quick idea of the age of Feature 10, a deep hearth that was the focus of much investigation in the Trench 1C area. Several additional AMS samples were pretreated by Herbert Haas of RC Consultants in Las Vegas, Nevada, and ten of these were dated by AMS methods at the ETH facility in Zurich, Switzerland. The stratigraphic contexts of the 11 dated samples and dating results are presented in Table 5. One additional conventional radiocarbon date, 710 $\pm$ 60 yr BP, not listed in Table 5 was produced by Geochron Laboratories on materials submitted independently by Roche Lindsey from Feature 5, the Late Prehistoric age pit intersected by Trench 4A. Nine of the dates listed in Table 5 are considered valuable sources of geochronologic information and figured prominently in subsequent interpretations. Two (Barnes #11 and Barnes #14) yielded geologically recent, late Holocene AMS ages, while the others produced dates of middle and late-early Holocene age (Table 5).

The stable carbon isotope analysis was conducted at Geochron Laboratories, Cambridge, Massachusetts, while the analysis of soil organic and inorganic carbon was performed at the Texas A&M Soil Characterization Laboratory in College Station, Texas. The stratigraphic unit samples, collected from Trenches 1A, 1B, 1C, 2A-2D, and 4A, were analyzed for texture and reaction at the offices of David Kuehn Consulting in El Paso, Texas. The textural analysis employed shaking through standardized wire-mesh screens for the sand fraction and settlement volumetric characteristics using a test tube-reagent apparatus for the silt and clay fractions

Table 5. Radiocarbon dating results and stratigraphic context for dates at the Barnes site, 5LA9187.

Catalog No. and Context (see Table 2 in Ch. 3)	Barnes No.	Lab Date No.	Uncal. ^{14}C Age BP	$\delta^{13}C$ Value	Stratigraphic Unit	Soil Horiz.
Late Prehistoric						
CN 1246, F8, XU26	14	ETH- 24882	717 ± 49	-11.8 ± 1.2	= Unit VII in Trench 1B?	Bkb1?
CN 1661, F5, Pit	11	ETH-24879	689 ± 49	-17.1 ± 1.2	Unit XIV	Bk
Trench 1C Area						
CN 1368, F10, XU30	0	Beta-158491	6800 ± 40	-11.5	Unit III	Bkb3
CN 1368, F10, XU30	1	ETH-24872	6992 ± 64	-20.7 ± 1.2	Unit III	Bkb3
CN 1347, F10, XU31	2	ETH-24873	6906 ± 68	-22.5 ± 1.2	Unit III	Bkb3
CN 1512, Trench 1C	4	ETH-24875	8059 ± 69	-24.7 ± 1.2	Unit II	Bkb4
CN 1514, Trench 1C	3	ETH-24874	7590 ± 72	-20.7 ± 1.2	Unit I	C
Trench 1A–1B Area						
CN 1492, XU 7, Level 10	9	ETH-24878	4658 ± 215	-24.4 ± 1.2	??	Bkb?
CN 1516, Trench 1B	5	ETH-24876	6323 ± 62	-20.4 ± 1.2	Unit I	Bkb5
CN 1505, XU5, Level 9	13	ETH-24881	6448 ± 61	-12.3 ± 1.2	= Unit III in Trench 1A?	Bkb2?
Trench 4A						
CN 1511, Trench 4A	8	ETH-24877	5535 ± 59	-26.1 ± 1.2	Unit Vb	Bkb2

(cf. Folk 1980). The samples were also analyzed for general reaction to a 10% solution of hydrochloric acid.

Other sedimentary and soil attributes, including unit thickness, unit and soil horizon boundaries, color, soil structure, primary sedimentary structure, soil consistence, and pedogenic carbonate accumulation, were recorded in the field. These followed the procedures outlined in the Soil Survey Staff (1951, 1990) and Boggs (1987).

Results and Interpretations

Geoarchaeological investigations at site 5LA9187 were undertaken in order to identify the stratigraphic and pedologic composition of late Quaternary sediments. AMS and standard radiocarbon ages were used to establish a basic geochronologic framework for concurrent archaeological data recovery. The research also focused on the diachronic reconstruction of local landscape conditions, and the identification of principal sedimentary depositional environments. The results of these investigations are presented according to research topic. We begin with a basic description of stratigraphy and soils.

Stratigraphic and Pedogenic Context

Natural sediments at site 5LA9187 are concentrated in two depositional terraces extant along the southwestern side of the unnamed arroyo, a tributary of the Purgatoire River. The terrace fill sediments were studied by examining the profiles exposed along the walls of four major backhoe trenches. The trenches extended from the arroyo channel southeast across the two terrace fills. Two of the trenches consisted of single, continuous exposures (Trench 3A and Trench 4A), while two were comprised of multiple trench segments (Trenches 1A, 1B, 1C and Trenches 2A, 2B, 2C, 2D) (see Figures 4 and 5, Chapter 2).

In each of the trench profiles, stratigraphic units (designated by Roman Numerals I, IIa, IIb, III, etc., in the profile drawings) were identified on the basis of lithologic characteristics, and were distinguished from overlying and underlying units by the presence of soils or abrupt, significant changes in lithology (i.e., lithic discontinuities). Both terraces were comprised primarily of medium to thick, parallel-bounded units of silty overbank alluvium, and occasional interbedded and/or laterally adjacent, channel deposits (sand and gravel). Additional meandering stream facies, such as natural levee and point bar, may have also contributed sediment to the terrace fill, but were difficult to identify (due to erosion, bioturbation, and pedogenic alteration).

Lateral cut-and-fill contacts were identified in Trenches 1A, 1B, 2D, and 4A, while abrupt vertical changes in lithology were encountered in Trenches 2A and 3A. The former illustrate truncation of the predominant overbank sediments by generally small, clearly defined channels, most of which subsequently in-filled with sand and gravel (Trench 1A, 1B, 2D, 4A). Two of these, in Trenches 1A and 4A, are situated on the riser between the T1 and T2 terrace fills, and may reflect the abandonment of T2 and the subsequent aggradation of T1 (which appears inset against the T2 fill). In Trench 2A, an abrupt vertical change in lithology reflects the upward-fining sequence of channel lag, point bar/natural levee, and overbank sediments commonly found in meandering stream environments (Allen 1970; Boggs 1987). In other trenches (Trench 3A, and possibly 4A), these abrupt vertical differences are less systematic, and could have resulted from the reworking of facies environments such as channel lag, point bar, or levee, during subsequent episodes of channel migration or incision (Boggs 1987:354-355).

Following is a more specific summary of stratigraphy and soils within the four principal backhoe trenches.

Backhoe Trench 1A (Figure 15)

This trench is a lengthening of the trench excavated during initial reconnaissance-level geoarchaeological investigations in October 2000 (see Figure 5, Chapter 2, for their relationship). As illustrated in Figure 15, the more recent profile includes the southeastern portion of the T1 terrace fill, the cut-and-fill contact between T1 and T2, and a substantial portion of the T2 fill. The T1 fill (Sediment Package 1 in Figures 5 and 8 in Chapter 2) includes stratigraphic Units VII and VIII, thick beds of clayey silt truncated laterally by one or more erosional events that occurred prior to the deposition of overlying Unit IX. Unit IX is a thick bed of very fine sandy silt overlain by Unit X, a thin bed of fine sandy silt with sparse granules (recent slopewash and/or eolian mantle?). The T1 sediments in Trench 1A appear to have experienced at least three episodes of soil formation. The first occurred after the aggradation of Unit VII and is represented by a Bk horizon (Bkb3) with stage 2 carbonate accumulation (cf. Gile et al. 1966). The second occurred after the deposition of Unit VIII, and is represented by another Bk horizon (Bkb2) with stage 1-2 carbonates. The final episode of soil formation began after the aggradation of Units IX and X, and is represented by a poorly formed surface soil (A/Bw profile).

The remaining portions of Trench 1A, beginning about .5 m – 2.5 m southeast of datum 1011.65N/1000.33E, and extending throughout the length of the trench, are comprised primarily of fine-grained overbank (Sediment Package 2, Chapter 2) and coarse-grained channel lag

(Sediment Package 3, Chapter 2) sediments. These are overlain by at least one younger colluvial/eolian unit (Unit X). The overbank materials include (from lowest to highest) Unit I - clayey silt, Unit III – silt, and Unit V – clayey and fine sandy silt (Figure 15).

Units IIa –IIc, IVa – IVo, and VIc represent former channel deposits (Figure 15). Units IIa - IIc are vertically adjacent beds of sand and gravel that together form a thick lenticular deposit. The deposit is not associated with a visible channel cut and may therefore represent channel lag sediments that have been reworked by channel migration or channel incision. Units IVa through IVo are thin to medium beds of massive sand and gravels that fill a distinctive, but somewhat irregular, channel cut. The channel sediments are inset against Unit III silts in the southeastern portion of the trench, and are in turn overlain by Unit V overbank and Unit VI, overbank and possible fine-grained channel fill, deposits (Figure 15). The Unit I – VI aggradational events were apparently followed by periods of landscape stability, recognizable by S1 – S4 soils. All are Bk horizons with varying amounts of pedogenic carbonates. The older S1 and S2 soils exhibit stage 3 and stage 2 carbonate development respectively (filaments, threads, nodules). The S3, S4, and S5 soils exhibit only stage 1 development (sparse filaments and threads).

Backhoe Trench 1B (Figure 15)

Situated a short distance east/southeast of Trench 1A, sediments exposed in this profile reflect the lateral and possible vertical truncation of fine silty overbank sediments (Units I – III) by at least one episode of channel migration and incision (Figure 15). Once established, the channel filled with coarse sand and gravel (Units IVa – IVh), which in turn were buried by renewed vertical accretion (Unit V-silt). A second, brief episode of channel incision appears to have followed the Unit V deposition, laterally truncating a portion of V and resulting in the deposition of a medium bed of sand and gravel (Unit VI). Both Units V and VI were subsequently covered by Unit VII, a medium to thick bed of very fine sandy silt (overbank), which in turn became overlain by a thin, occasionally discontinuous, mantle of pebbly colluvium and possible eolian silt (Unit VIII). The profile contains as many as 5 soils, 4 of which are buried Bk horizons developed after the aggradation of Units I, II, III, and V (Figure 15). The fifth represents the poorly developed surface soil (A/B – C profile). The oldest soil, S1, is associated with Unit 1 (clayey silt) and exhibited late stage 2 carbonate development (coalescing filaments and threads, few nodules). The overlying soil, S2 (fine sandy silt) also contained stage 2 carbonates, but with very few nodules (cf. Gile et al. 1966). The remaining Bk horizons, associated with Units III and V (silt), exhibited stage 1 carbonate development (few filaments and threads, mostly powdery). A charcoal sample from Unit 1 yielded an AMS age of 6323 ± 62 yr BP (ETH-24876) (Table 5, Figure 15). This age suggests that the truncation of Units I – III by channel migration and incision occurred sometime after ca. 6300 BP.

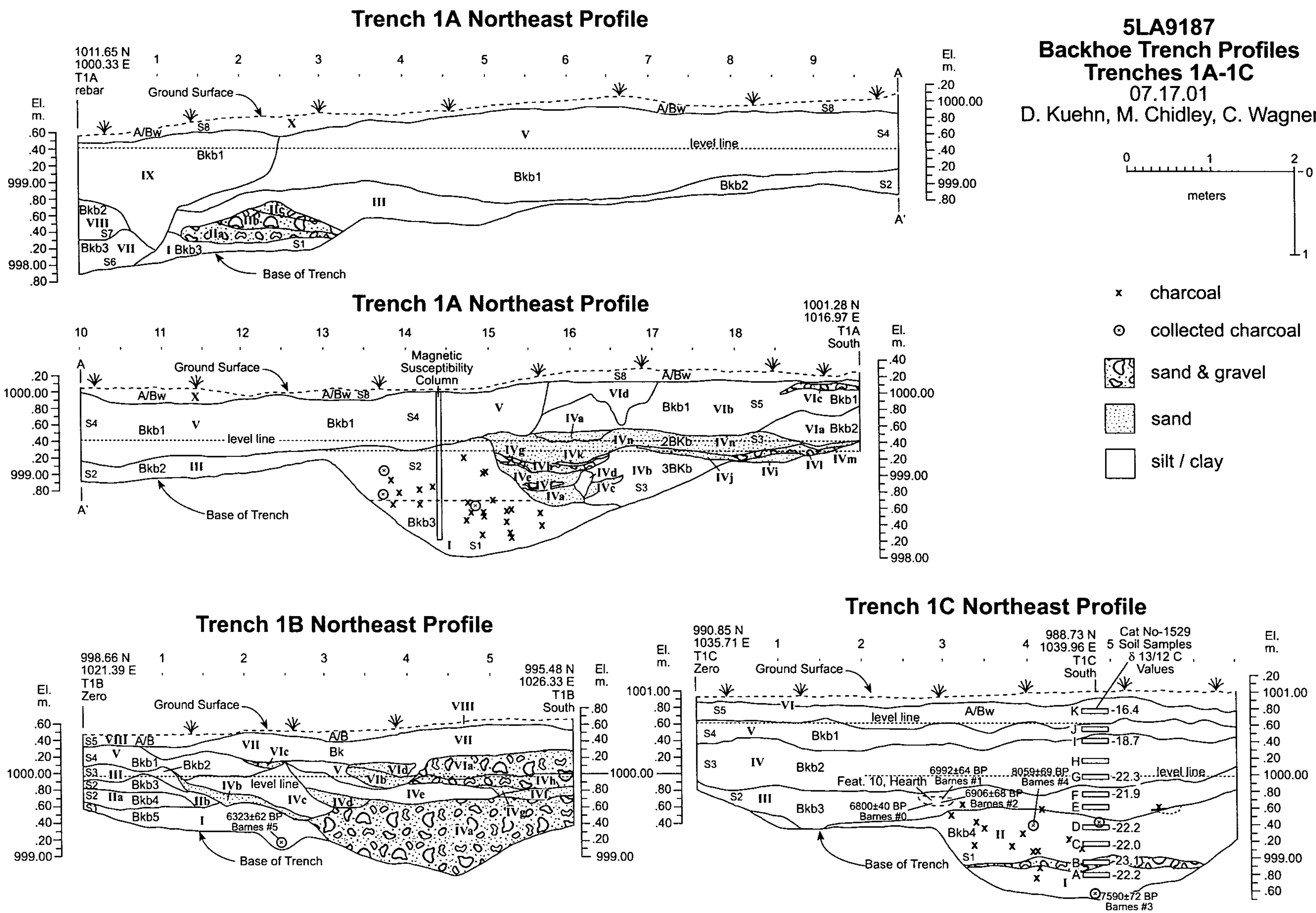

Figure 15. Profiles for backhoe Trenches 1A, 1B, and 1C at the Barnes site, 5LA9187.

Backhoe Trench 1C (Figure 15)

The last of the Trench 1 profiles, Trench 1C is one of only three trench segments not impacted to some extent by channel migrations and incision or the reworking of channel lag gravels (Sediment Package 5 as shown in Figures 5 and 8, Chapter 2). The others are Trenches 2B and 2C. At Trench 1C the only potential exception is a very thin bed of sand and gravel in the bottom of Unit II, which is too ephemeral to identify depositionally. Five of the six stratigraphic units at Trench 1C are fine-grained vertical accretion deposits. These include (from lowest to highest) Unit I – silty clay, Unit II – silty clay, Unit III – fine sandy silt, Unit IV – clayey silt, and Unit V – fine sandy silt (Figure 15). The remaining unit, Unit VI, is a medium to thick bed of gravelly, fine sandy silt. It is located at the top of the profile and represents a recent colluvial or eolian mantle at the site surface.

A minimum of five soils (S1 – S5) has been tentatively identified at Trench 1C. These reflect intervals of stability that occurred between the aggradation of Units II, III, IV, V, and VI. All except S5 (recent) are buried Bk horizons with varying amounts of pedogenic carbonates. None are associated with A horizons, except the present surface soil, S5, which has a simple A – Bw profile (Figure 15).

Table 6 is a summary of organic carbon (OC) content from Trench 1C and excavation Unit 2. Of the eight stratigraphic units analyzed from Trench 1C, the highest percentage of organic carbon was found in sample K from Unit VI, the A/Bw surface soil (0.80%). The other units were sampled as follows: Unit I – sample A, Unit II – samples B, C, D, Unit III – sample F, Unit IV – samples G & I. The OC percentages in these samples ranged from a low of 0.44% in samples A (Unit I - bottom of profile) and G (Unit IV – center of profile), to highs of 0. 64 – 0.60% in samples B, C, D (Unit II). These values illustrate the overall paucity of organic carbon in the Trench 1C sediments as a whole, and strengthen the argument for erosional truncation of former A horizons in the S1 –S4 soils. Additional evidence for the erosion of former A horizons includes a lack of any visible darkening within the soil horizons, and the wavy to irregular nature

Table 6. Soil organic and inorganic carbon (%) from backhoe Trench 1C and excavation Unit 2, 5LA9187.

Sample Catalog Number	Trench or XU	Strat Unit	Soil Horizon	%Organic Carbon	% Calcite	% Dolomite	$\%CaCO_3$ Equivalent (Inorganic C)
1529A	Trench 1C	I	C	0.44	29.4	2.2	31.8
1529B	Trench 1C	II	Bkb4	0.64	31.0	3.9	35.2
1529C	Trench 1C	II	Bkb4	0.63	21.4	3.3	25.0
1529D	Trench 1C	II	Bkb4	0.60	20.8	2.4	23.4
1529F	Trench 1C	III	Bkb3	0.52	17.7	2.1	20.0
1529G	Trench 1C	IV	Bkb2	0.44	18.9	2.6	21.7
1529I	Trench 1C	IV	Bkb2	0.45	38.3	3.2	41.8
1529K	Trench 1C	VI	A/Bw	0.80	28.7	3.3	32.3
1526B	Unit 2	I	Bkb3	0.52	28.9	1.9	31.0
1526F	Unit 2	IIId	Bkb1	0.54	29.2	1.8	31.2

of boundaries between the buried Bk horizons. Erosional unconformities, or disconformities, are characterized by irregular, concave, or undulating unit contacts (Boggs 1987:527) and are frequently associated with truncated surface horizons (Waters 1992:72-73). Undulating or irregular contacts were evident at the upper contact of every BK horizon in the trench profile.

Soil carbonates in Trench 1C ranged from diffuse powdery forms and very few filaments in S4 (weak stage 1) to more abundant filaments and threads with powdery forms between peds in S3 (stage 1), to abundant, thickened filaments and threads and few nodules in S2 (stage 2), and coalescing filaments and treads with moderate nodules in S1 (early stage 3).

Charcoal samples from Trench 1C yielded five AMS ages (Table 5). These were from samples collected from Unit I (7590 ± 72 yr BP – ETH 24874), Unit II (8059 ± 69 yr BP – ETH 24875), and Unit III (6800 ± 40 yr BP – Beta 158491; 6906 ± 68 yr BP – ETH 24873; 6992 ± 64 yr BP – ETH 24872). As previously stated, the oldest date, 8059 ± 69 BP is stratigraphically incongruent with the other ages and is not considered reliable due to small sample size that prohibited full pretreatment without complete loss of sample. The three ages from Unit III (6800 – 6992 BP) were associated with a prehistoric hearth feature that appears to represent the oldest evidence of cultural activity at 5LA9187. The ages from Units I – III indicate that the lower ca. 1.4 m of sediment at Trench 1C was deposited between ca. 7600 and 6800 yr BP.

Backhoe Trench 2A (Figure 16)

Trench 2A was placed near the extreme southwestern edge of the 5LA9187 site area (Figure 4, Chapter 2). It was comprised of four individual segments, the largest of which was Trench 2A. Beginning at a cutbank above the unnamed arroyo channel, the trench extended southeast across the T1/T2 fill for 20.23 m (Figure 16). It was comprised of 10 lithostratigraphic units arranged as horizontally bounded and lenticular, thin to thick beds of sand, gravel, and silt, and a number of possible trough cross-bedded units of sand and gravel (Figure 16). These appear in a generally systematic fining-upward pattern that is consistent with superimposed channel – point bar- and floodplain facies in meandering stream environments (cf. Allen 1970; Brakenridge 1987; Boggs 1987; Walker and Cant 1984). Primary sedimentary structure was difficult to discern because of bioturbation and soil formation. Also, some of the sand and gravel beds were discontinuous and not overly indicative of any specific depositional environment. These deposits suggest an element of disturbance during episodes of channel migration, incision, or gullying. The profile therefore appears to be the product of multiple processes.

Unit I, at the bottom of the profile, is a thick to medium bed of massive to weakly blocky, fine sand. Both the upper and lower unit contacts undulate markedly. The Unit I sands are overlain by Units IIa - IId, horizontally bounded, discontinuous thin to medium beds of poorly sorted sand and gravel (Figure 16). At the extreme northwestern end of the trench, Unit II sediments are partially truncated, and overlain by planar bedded and medium-scale trough cross-bedded sands and very small gravels (Unit IIIa and IIIb). Unit III is partially covered by Unit IV, a thick bed of fine sand. In the central portion of the trench profile, Unit IV overlies Unit II, while in the southeastern portion of the trench it overlies Unit I.

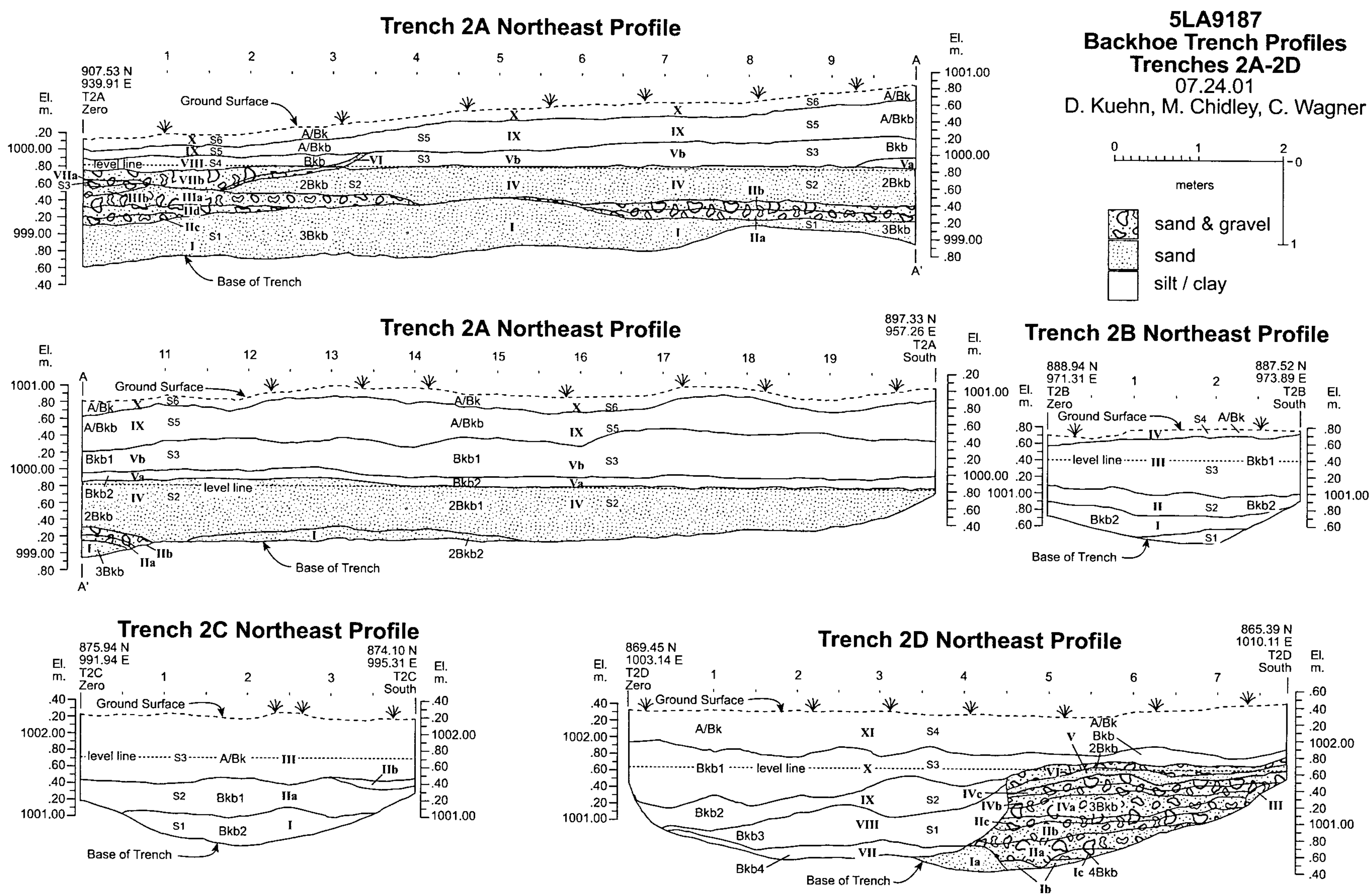

Figure 16. Profiles for backhoe Trenches 2A, 2B, 2C, and 2D at the Barnes site, 5LA9187.

After the aggradation of Unit IV, the depositional environment changed from lateral accretion via channel lag (gravels) and point bar (sands), to fine-grained vertical accretion (overbank). These deposits are represented in Units Va (sandy silt and fine sand), and Vb (very fine sandy silt). Unit Vb is overlain by Units IX (silt) and X (colluvial/eolian surface mantle). Prior to the aggradation of Unit IX, Units IV and Vb were laterally truncated and inset with Units VI, VII, and VIII (Figure 16). These units consist of sand, small gravels, and sandy silt, and are preserved only in the northwestern end of the trench. Again, the entire sequence is covered by vertical accretion sediments, slopewash, and possible eolian silt.

The deposition of sediments in Trench 2A was interrupted by as many as six episodes of stability and soil formation. These episodes are reflected in soils S1 – S6 (Figure 16). Soils S1 – S4 are buried Bk horizons, while S5 and S6 contain A/Bk and A/Bkb horizon profiles. Pedogenic carbonates in S1 and S2 consist of sparse to moderate filaments and threads (late stage 1). In the S3 and S4 soils, carbonates are limited to very few filaments and threads, most of which follow rootlets (stage 1).

Backhoe Trenches 2B and 2C (Figure 16)

These are short segments of trench that were placed between 2A, at the edge of the Lockwood channel, and 2D, the furthest trench away from the channel (Figure 4, Chapter 2). They are 3-4 m long and comprised entirely of vertical accretion deposits.

The Trench 2B stratigraphic profile consists of four lithostratigraphic units and 3 – 4 soils. Units I and II are medium beds of fine sandy silt and silty clay. Both are associated with former surface soils, but these have been eroded and are now single Bkb horizons. The Unit I, S1 soil contains late stage 2 – early stage 3 carbonates, while the Unit II soil exhibits sparse to moderate filaments and threads indicative of late stage 1 or early stage 2. Unit III is a thick bed of fine sandy silt. The S3 soil is represented by a single Bkb horizon with strong, small subangular blocky structure and stage 1 carbonates. It is overlain by Unit IV (pebbly fine sandy silt) and S4, a thin, poorly developed A/Bk surface soil (Figure 16).

Trench 2C contains three lithostratigraphic units (clayey silt, silty clay, fine sandy silt). Three soils are evident in the 2C profile, two of which are buried. The lowest, S1, is a Bkb horizon with early stage 3 carbonate development. The second lowest, S2, is also a single Bkb horizon, but carbonate development is stage 2. The third soil, S3, contains an A/Bk horizon profile, and very few carbonates (powdery forms along ped faces). S3 forms the modern surface soil in this portion of the site.

Backhoe Trench 2D (Figure 16)

This ca. 8-m long trench segment is unusual in that the stratigraphy reflects channel lag sediments (gravel) that have been laterally truncated by a migrating channel (Figure 16). The channel lag deposits consist of six stratigraphic units, three of which are divided into subunits. The lowest, Unit I, consists of small-scale trough cross-bedded sand. Overlain by channel lag gravels, cross-bedding is not a particularly common form of bedding in channel lag deposits, which are most often massive or planar bedded (cf. Boggs 1987:355-356). Small-scale trough

cross-bedding is a characteristic of the upper portions of sandy point bar sequences, and is common in sandy longitudinal and transverse bars associated with braided streams (Walker and Cant 1984; Allen 1970). While there is no evidence from 5LA9187 to suggest that the unnamed arroyo had a braided pattern any time during the Holocene, it is interesting to note that channels on the floor of larger gullies are often braided (Waters 1991:145-146; Schumm and Hadley 1957).

The Unit I sands are overlain by four thin, generally planar-bounded, beds of sand and gravel. Both the Unit I sands and the Unit II – VI gravels were laterally eroded by channel migration and possible incision. The ca. 4.4 m wide channel, as evident in cross-section, is filled with three medium to thick beds of silt and fine sandy silt (Figure 16). The configuration of the channel suggests that its long axis was roughly parallel to the long axis of the unnamed arroyo channel in its current position. The channel fill units (VII, VIII, and IX) are overlain by Unit X, a thick bed of clayey silt that also covers the Unit VI gravels (Figure 16). Unit X is overlain by Unit XI, a thick bed of sandy silt. Soil formation is evident throughout the trench profile, and appears associated with four episodes of pedogenesis. As usual, all are comprised of single Bk horizons, except for S4, the surface soil, which has an A/Bk profile (Figure 16). The two lower soils have stage 2 and/or early stage 3 carbonate development, while S3 and S4 have stage 1.

Backhoe Trench 3A (Figure 17)

Located near the northern edge of the site, Backhoe Trench 3A had a single segment, that began near the cutbanks above the unnamed arroyo and extended southeast for ca. 25.5 m (Figures 5, Chapter 2). The trench profile is comprised of four stratigraphic units, three of which have been subdivided (Ia –If, IIa – IId, IIIa – IIIb) (Figure 17). All but eight of these are silty overbank sediments. The others are thin, discontinuous beds of sand and gravel.

The lowest unit in Trench 3A, Unit Ia, is thick bed of fine sandy clay. These Bk horizon sediments also include four small, highly irregular thin bodies of sand and gravel. Devoid of form, these unusual intrusions have no readily identifiable environmental source. Unit Ia is overlain by Unit IIa and, in some places, Unit IIb (Figure 17). Unit IIa is a thick but discontinuous, bed of massive fine to medium sand. The lower portions of IIa appear to have been impacted by rodent activity. This activity could also potentially be the origin of the irregular sand and gravel deposits in Unit Ia. In the northwest and central portions of Trench 3A, Unit Ia is overlain by Unit IIb, a thick and discontinuous bed of clayey silt. The unit has very irregular upper and lower contacts. Unit IIIa is a small, lenticular-shaped bed of sand and gravel situated at the far northwestern end of the trench. Unit IIIa is overlain by Unit IIIb, a thick, fairly uniformly bounded, bed of silt and fine sandy silt (Figure 17). Unit IIIb, in turn, is overlain in places by Unit IV, a thin, discontinuous bed of gravelly fine sandy silt.

Trench 3A contains evidence of four soil forming episodes. The oldest S1, is a Bkb horizon with stage 2 carbonates (coalescing filaments and threads). S2, another Bkb horizon, formed in Units IIa and IIb, and also contains stage 2 carbonates. S3, the most recent Bkb horizon, has stage I carbonates and is partially buried by S4, the ephemeral A/Bk surface soil. S4 has undergone recent episodes of deflation and possible eolian or colluvial deposition. Interestingly,

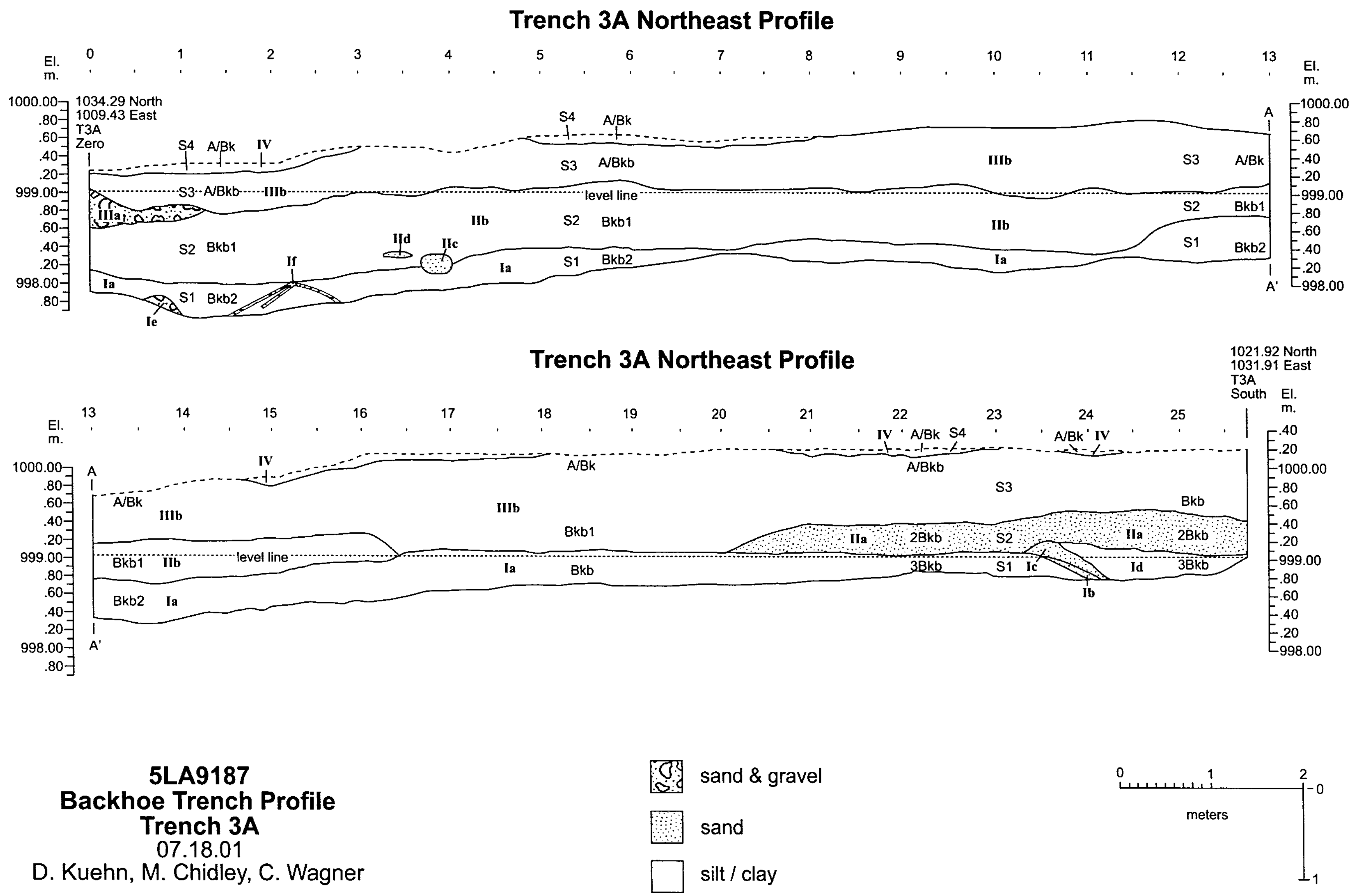

Figure 17. Profile of Backhoe Trench 3A at the Barnes site, 5LA9187.

this periodic sedimentation has served to expose, and then bury, the upper portions of S3 (Unit IIIb).

Backhoe Trench 4A (Figure 18)

This important trench, a single segment located between Trench 1 and Trench 2, extended from the cutbanks above the unnamed arroyo, southeast for 27 m (Figure 5, Chapter 2). The Trench 4A profile is a complicated assortment of vertical accretion, channel lag, coarse and fine channel fill, and possible reworked sand and small gravelly point bar sediments (Figure 18). The oldest sediments are exposed in the southeastern end of the trench and are arranged in two cut-and-fill channel sequences delineated by two erosional unconformities (Figure 18). The first, located from ca. 1.5 m to the northwest and .5 m to the southeast of datum 987.01 North/990.52 East, includes Units Ia and Ib, thin lenticular and thin/partially truncated beds of silty clay and fine sandy silt (overbank?). Overlying Unit Ib was scoured by channel incision subsequent to aggradation. The small channel overlying Ib was filled with massive, fine to medium sand (Unit II), which in turn was overlain by fine sandy silt (Unit III – overbank). Both Units II and III were subsequently truncated laterally by a second episode of channel erosion (migration and incision). This rather small, steep-sided channel, filled with gravel (Unit IV) massive sands (Unit Va), and eventually, sandy silt and clayey silt vertical accretion sediments (Unit Vb). Both Units III and Vb were eventually covered with a medium bed of planar-bounded silt (Unit VI).

At the northwestern end of Trench 4A, subsequent to the aggradation of Unit 1, and either synchronous with, or slightly before, the aggradation of Units IV and Va, a number of thin, irregular beds of sandy silt and fine sand were deposited. These sediments, Units VII – X, may reflect alternating episodes of overbank and natural levee deposition. Vertical accretion is indicated in Units VII, VIIIa, IXa. IXd, and Xb (silt, clayey silt, fine sandy silt). These units are inter-bedded with Units VIIIb and Xa, thin to medium beds of massive and ripple-laminated fine sand (cf. Boggs 1987:156-160). These types of sandy bedding are most commonly found in natural levee environments, and to some extent, in the upper reaches of sandy point bars (Boggs 1987; Walker and Cant 1984; Allen 1970; Reineck and Singh 1980).

The upper portion of the Trench 4A profile is comprised of irregular and discontinuous, thick - thin beds of silt and fine sandy silt (Units XIa, XIIa – XIIc, XIII, XIV). These reflect the final aggradation of overbank sediments in this area. In the southeastern portion of 4A, the silty overbank deposits are separated by four vertically adjacent beds of sand and gravel (Units XId – XIg). Lenticular but undulating and abruptly discontinuous, these gravels appear as channel lag deposits that were shifted laterally and redeposited during meandering stream channel migration (Boggs 1987:357; Allen 1970).

Soils in the Trench 4A profile are complex due to the numerous vertical and lateral changes in sediment lithology, but remain basically similar in terms of horizon development. As many as 11 soils are evident in the Trench 4A fill. At the northwestern end of the trench, the vertical soil column consists of S11 (surface A/Bw), S10 (A/Bkb), S9 (Bkb2), S8 (2Bkb), and S7 (3Bkb). At the southeastern end of the trench, in the Unit Ia – III channel cut-and-fill, the profile is comprised of S11 (surface A/Bw), S5 (Bkb1), S3 (Bkb2), S2 (2Bkb), and S1 (3Bkb).

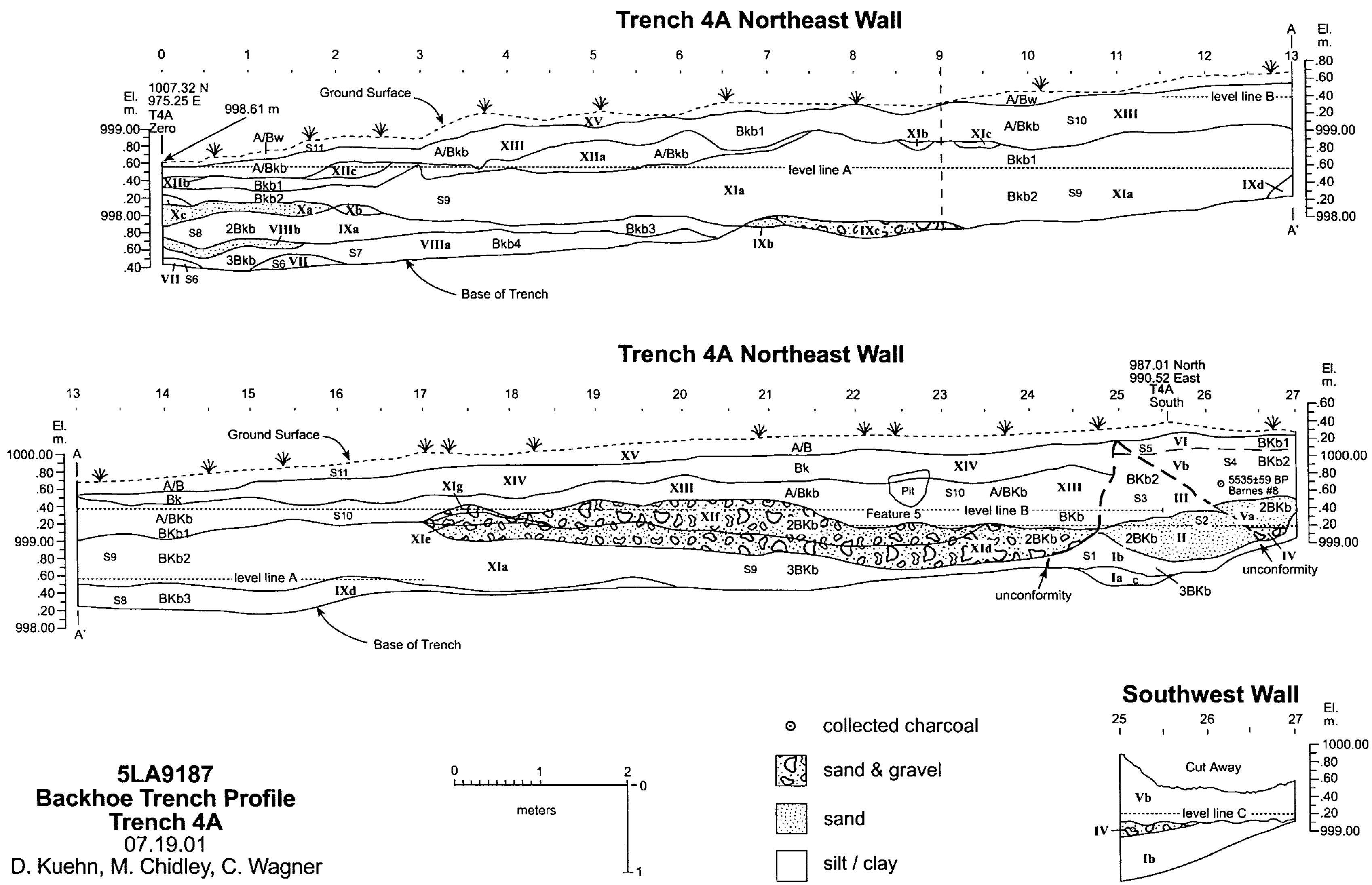

Figure 18. Profile of Backhoe Trench 4A at the Barnes site, 5LA9187.

Immediately northwest of Unit Ia, in the gravelly XId – XIg deposits, the vertical profile includes S11 (A/B surface), S10 (A/Bkb and 2Bkb), and S9 (3Bkb).

Early stage 3 carbonate accumulation is evident in Units Ia and Ib, while stage 2 development characterizes Bk soils in Units II, IV, IXd, IXb, VII, and VIIIa (Figure 18). In the overlying units, carbonates rapidly decrease to stage 1 forms.

A charcoal sample collected from Unit Vb, in the channel cut-and-fill at the extreme southeastern end of the trench, yielded an AMS age of 5535 ± 59 yr BP (ETH-24877) (Table 5, Figure 18). This age indicates that Unit Ia and Ib, carbonate-rich silty clay and sandy silt, were deposited prior to ca. 5500 BP, as were the Unit II channel fill deposits. The radiocarbon age from Unit Vb also has implications for the age of sediments and depositional events in other backhoe trenches. These will be discussed in a subsequent section.

Stable Carbon Isotope Values

Stable carbon isotope values from soil organic matter have received considerable attention in recent years for their potential usefulness in paleoenvironmental reconstruction (Cerling et al. 1989; Kelly et al. 1991; Boutton et al. 1993, Boutton et al. 1998). This usefulness stems from their ability to record the contribution of C3 and C4 plants to the overall isotopic composition of previous plant communities. C3 and C4 are two of three categories of plants that follow different metabolic pathways while converting CO_2 into carbohydrates during photosynthesis. The other category consists of CAM plants, or desert succulents. C3 and C4 plants are the two suitable for use in paleoenvironmental reconstruction because they have distinctive $\delta^{13}C$ signatures and very different evolutionary adaptations to climatic conditions, particularly conditions of temperature and effective moisture (cf. Cerling 1989; Herz 1990). C4 plants convert CO_2 into tissue in less time and with less water than do C3 plants. They also discriminate less against $^{13}CO_2$ than C3 plants, and therefore end up with lower $\delta^{13}C$ values (Park and Epstein 1960). C4 plants thrive in warm, semiarid environments such as tropical and subtropical grasslands, while C3 plants thrive in cooler and more humid to subhumid temperate regions like the forests of northeastern North America. C4 plants have an average $\delta^{13}C$ value of -12.5‰, while C3 plants have an average $\delta^{13}C$ value of -26.5‰ (Kelly et al. 1991). The percentage of C3 and C4 plants at any given locality is therefore a strong indication of local temperature and precipitation conditions (cf. Boutton et al. 1993; Herz 1990). During decay and transformation into humus, the isotopic composition of plant-derived material changes little (Nadelhoffer and Fry 1988). As a result, the isotopic composition of soil organic matter, and its measurable constituent, organic carbon, are reflections of the plant community that produced them.

In addition to entering the soil profile by vertical translocation from surface horizons, where it originates from the decay of plant (and animal) remains, organic carbon in soils can also be the product of non-pedogenic sources. The primary source of "inherited" organic carbon is geologic parent material (cf. Nordt et al. 1994). In the case of site 5LA9187, geologic parent materials are the alluvial sediments that were transported and deposited in the site area by channelized or overbank discharge during episodes of local flooding. This material may include alluvium stored in upstream portions of the drainage basin, or sediments originating in landforms

along the slopes and margins of the drainage basin. The former were therefore reworked one or more times prior to deposition in the site area, while the latter are frequently sediments derived from the weathering of local outcrops of bedrock. In this case, bedrock sources in upstream portions of the drainage basin are mapped as Niobrara Formation (Cretaceous), which is comprised of calcareous shale and limestone (Tweto 1979).

The carbon isotope samples collected from Trench 1C and excavation Unit 2 were examined for their potential usefulness as proxy indicators for climatic conditions associated with the aggradation of the T2 terrace fill. The results of the analysis, presented in Table 7, show a predominance of relatively low $\delta^{13}C$ values, in Trench 1C ranging from -23.1‰ to -16.4‰, and in excavation Unit 2 from -24.4‰ to -18.7‰. With a global average C3 plant value of -26.5‰, the samples at 5LA9187 with values lower than -20.0‰ would certainly suggest a predominance of C3 plants in the overall plant biomass that contributed to local soil organic matter. For example, a value of -20.4‰ would indicate approximately 53% C3 carbon (Boutton et al. 1998:659). These levels of C3 productivity are suggested in 6 of the 8 samples collected from Trench 1C and in 1 of the 2 samples collected from excavation Unit 2 (Table 7).

Table 7. Stable carbon isotope ratios on soil organic matter (OM), backhoe Trench 1C and excavation Unit 2, 5LA9187.

Sample Cat. No.	Trench or XU	Strat. Unit	Soil Horizon	Material	$\delta^{13}C$
1529-A	Trench 1C	I	C	Soil OM	-22.2
1529-B	Trench 1C	II	Bkb4	Soil OM	-22.9, -23.1
1529-C	Trench 1C	II	Bkb4	Soil OM	-22.0
1529-D	Trench 1C	II	Bkb4	Soil OM	-22.2
1529-F	Trench 1C	III	Bkb3	Soil OM	-21.9
1529-G	Trench 1C	IV	Bkb2	Soil OM	-22.3
1529-I	Trench 1C	IV	Bkb2	Soil OM	-18.7
1529-K	Trench 1C	VI	A/Bw	Soil OM	-16.4
1526- B	Unit 2	I	Bkb3	Soil OM	-18.7
1526-F	Unit 2	IIId	Bkb1	Soil OM	-24.4

A closer examination of the $\delta^{13}C$ values from Trench 1C illustrates that the only samples from the entire profile that were not appreciably affected by soil pedogenesis, samples 1529-A and 1529-B, had two of the lowest $\delta^{13}C$ values (-22.2‰ and -22.9/-23.1‰). On the other hand, the highest $\delta^{13}C$ value, -16.4‰, was from the only sample in the profile that was collected from a surface (or former surface) A soil horizon, that being sample 1529-K, which was obtained from a sample of the present surface soil (A/Bw profile). This value, and the one from the upper portion of the underlying Bkb2 horizon (-18.7‰ sample 1529-I), were the only two exhibiting evidence of significant C4 plant input. These suggest C4 carbon productivity on the order of ca. 70% in sample 1529-K and ca. 60% in sample 1529-I (cf. Boutton et al. 1993:5-7). The four remaining samples from Trench 1C, 1529-C, D, F, G, were all recovered from clear Bk soil horizons, the first three of which were from soils with very high (stage 2-3) accumulations of pedogenic carbonates. These almost certainly formed under conditions of reduced rainfall and higher annual temperatures, when precipitation was not sufficient to vertically transport the highly soluble carbonate minerals out of the former soil profiles. As a result, while the low $\delta^{13}C$ values from samples 1529-C, D, and F, are strongly suggestive of C3-dominated plant biomass, which

should have accumulated under cool and moist temperate conditions, the soils from which they were recovered are temporally and morphologically suggestive of aridity. It would first appear, therefore, that the climatic implications of the $\delta^{13}C$ values from samples 1529-C, D, and F are not consistent with the climatic implications of high pedogenic carbonate accumulation in the same soil horizons. In addition, the only sample from an extant A horizon, the modern surface soil, yielded the highest overall $\delta^{13}C$ value, indicative of a predominance of C4 carbon in the local biomass. This is an apparently accurate value given the temperature and semi-arid precipitation levels in this midlatitude portion of the Great Plains (cf. Gale 1985).

The carbon isotope samples from Trench 1C are associated with soil organic carbon (OC) percentages that range from 0.80 to 0.44. These are all generally low and reflect the overall paucity of soil A horizons in the profile. In all but humid or ponded environments, soil organic matter is most frequently concentrated in the A, or surface, horizon due to the decomposition of floral, and to a lesser extent, faunal materials. In Mollisols, or dark epipedons characteristic of thick prairie grassland environments, the amount of soil organic carbon frequently exceeds 2.5% (Soil Survey Staff 1990:6). In research conducted in the semiarid environment of western North Dakota, a climatic setting not too unlike that of site 5LA9187, soil organic carbon content in A horizon samples from the late Holocene frequently ranged from between 1.1 – 1.6% (Kuehn 1995:84-93).

At Trench 1C, the sample with the highest organic carbon is 1529-K (0.80%), the poorly developed surface horizon, and the only A horizon in the profile (Table 6). This is the sample that produced the highest $\delta^{13}C$ value of -16.4‰ (Table 7). The lowest OC percentages are associated with samples 1529-A and 1529-G (both 0.44%). Sample 1529-A was collected from unaltered alluvial parent material at the bottom of the sequence and was not part of a soil profile (Figure 15). Sample 1529-G came from the lower portion of a Bk horizon soil that exhibited some C horizon characteristics such as weak soil structure (Figure 15). Samples 1529-A and G yielded $\delta^{13}C$ values of -22.2 and -22.3‰, which were two of the lowest $\delta^{13}C$ values of the entire section. Three of the four remaining samples were collected from the carbonate-rich Bk horizons (samples 1529-C, D, F), and had intermediate organic carbon percentages (0.63 -.52%), but next to lowest $\delta^{13}C$ values (-22.2 to -21.9 ‰). The organic carbon data at Trench 1C therefore tend to follow the expected pattern of decreasing percentages with depth below surface, or higher volumes in extant A horizons, transitional volumes in B horizons, and lower volumes in C horizons, or parent materials.

These characteristics of the $\delta^{13}C$ and organic carbon records from Trench 1C suggest that, with the possible exception of the extant surface soil, stable carbon isotope values may not necessarily be a result of the pedogenic processes of decay and vertical organic carbon translocation. This leaves inherited carbon as the other potential source. The strongest evidence for a pedogenic source may lie, not in the carbon isotope samples from Trench 1C or excavation Unit 2, but in the $\delta^{13}C$ values of charcoal samples submitted for radiocarbon analysis.

Out of the 11 AMS dates reported from the excavations at 5LA9187, five were derived from charcoal samples recovered from archaeological contexts (i.e., prehistoric fire hearth or pit features), while six were recovered from apparently natural accumulations of charcoal within the alluvial terrace-fill sediments (Tables 2 and 5). The charcoal associated with the cultural

features could have been intentionally carried into the site area by humans and are not reliable indicators of local plant community composition. The samples of naturally occurring charcoal, on the other hand, could potentially represent dominant vegetative species and may therefore shed light on the question of organic carbon origin in local soil profiles. Of the six natural charcoal samples (Barnes # 4, 3, 9, 5, 13, and 8), all but one yielded low $\delta^{13}C$ values (-26.1 to -20.4‰, average value of -23.3‰) (Table 5). The sixth (Barnes #13) had a $\delta^{13}C$ value of -12.3 $\pm$ 1.2 and is decidedly C4. With an average value of -23.3 $\pm$ 1.2‰, the naturally occurring charcoal samples are consistent with the generally low values recovered from the $\delta^{13}C$ samples at Trench 1C and excavation Unit 2 (average of -22.6‰ from the seven samples with values lower than -20.0). This could eventually prove significant, but without additional research, the $\delta^{13}C$ values from naturally occurring charcoal cannot be identified as representative of the entire range of plant species that may have contributed organic carbon to local soil regimes. Many grass species, for instance, do not normally generate datable –sized pieces of charcoal when burned, and yet may have contributed greatly to local plant biomass. On the other hand, woody C3 species may have been plentiful in the site area in the past and their contribution to the soil organic carbon record may have been substantial. It is not possible, however, to quantify the relationship between the $\delta^{13}C$ values from naturally occurring charcoal and the $\delta^{13}C$ composition of subsurface soil samples at this time.

In summary, stable carbon isotope ratios from soil organic carbon at Trench 1C and excavation Unit 2 were generally low, with $\delta^{13}C$ values lower than -20.0 evident in seven of the ten samples analyzed. These samples were collected from unaltered alluvial parent material, the lower, transitional portions of Bk horizons, and from clear Bk horizon contexts and are indicative of the predominance of C3 plant productivity. They are also associated with generally low percentages of organic carbon, therefore following expected patterns in the vertical translocation of soil organic matter. The only sample associated with a surface horizon (extant or former) in the two profiles, is the one collected from the present surface soil at Trench 1C. This sample yielded the highest $\delta^{13}C$ value of the 10 analyzed, indicating a predominance of C4 plant productivity in very times. With low values in alluvial parent materials and relatively high values in the surface horizon, it cannot be assumed that the low values from remaining Bk horizon contexts, although predominate in both profiles, are necessarily the result of pedogenic translocation. Inherited sources for organic carbon cannot therefore be ruled out as a potential contributor to the $\delta^{13}C$ record at these localities.

Sedimentary Depositional Environments at 5LA9187

Site 5LA9187 is located in the headward subarea of the arroyo drainage basin, within a shallow valley formed by the incision and alluvial denudation of Cretaceous Graneros or Carlyle shale (Tweto 1989; Ritter 1978:205; Hadley and Schumm 1961). In this portion of the basin, substantial quantities of sediment are stored in two former floodplains, designated T1 and T2. Both depositional terraces are situated along the south/southwestern side of the arroyo channel, which follows a moderately meandering pattern in this area (see Figures 1, 2, and 3, Chapter 2) (Schumm 1977; Ritter 1978:236-237). The T2 terrace fill abuts against shale bedrock (valley wall) to the southeast and is separated from the T1 terrace fill by a 0.6 m high riser. The T1 fill extends from a number of cut-and-fill contacts with the T2 sediments, northwest for ca. 25 m to a series of cutbanks above the Lockwood tributary channel. An active point-bar and gentle valley

slopes characterize the landforms on the opposite side of the stream from 5LA9187. Shale bedrock is exposed along the side of a cutbank situated immediately west/southwest of the point-bar. Other shale outcrops are visible along the valley margin ca. 150 – 200 m to the east/southeast. The unnamed arroyo channel, dry during the field investigations, contains moderate to poorly sorted sand and gravel lag deposits along the bottom of the thalweg, and occasional sandy lateral bars in adjacent areas. A number of small gullies, in differing stages of development, are extant along the terrace-fill side of the stream. These are oriented roughly perpendicular to the long axis of the channel, and have resulted in small-scale degradation of the terrace-fill sediments.

The principal sedimentary depositional environments associated with meandering streams in general include the main channel, point bars, natural levees, the floodplain (flood basin), oxbow lakes, and meander cutoffs (cf. Allen 1970; Walker and Cant 1984; Reineck and Singh 1980). Three of these (channel, point bar, former floodplain/current floodplain) are extant as surface features within the 5LA9187 site area. Possible natural levee deposits were observed on eroded floodplain deposits upstream ca. 150 m from 5LA9187. Oxbow lake and meander cutoff environments are considered unlikely in the unnamed arroyo drainage basin due to insufficient sinuosity of the master stream channel.

The stratigraphic composition of the terrace fill sediments at 5LA9187 indicates that floodplain aggradation during episodes of overbank discharge was the predominate environment responsible for deposition at the site (cf. Allen 1970; Walker and Cant 1984; Brakenridge 1987). Overbank deposits are often near the top of a fining-upward sequence that is considered characteristic of meandering streams. This is because, at any given point in time, deposition can take place simultaneously within the different meandering stream environments (Boggs 1987:357), such as lag gravel deposition in the channel, cross-bedded coarse sands in the point-bars, and planar laminated fine sands and muds in the natural levees. Because meandering streams are particularly prone to migration and the lateral shifting of depositional environments across the valley floor, over time sediments associated with these environments frequently become superimposed. The result is a sequence where coarse lag gravels form the bottom of the profile, and are in turn overlain by sandy point bar and natural levee deposits, and finally, fine-grained silt and clay overbank sediments (Allen 1970; Walker and Cant 1979; Boggs 1987). Also termed vertical accretion sediments, overbank deposits form when silts and clays settle out of suspension in receding floodwaters.

While fining-upward sequences are the idealized form of meandering stream deposition, they are by no means the only form, and variations in meandering stream profiles are common (Collinson 1978). These variations can result from frequent deposition without overbank flooding, changing flow patterns, and coarse-grained point bar construction (Collinson 1978). Fluctuations in sediment deposition, often in response to changes in climate, can also produce vertical meandering sequences that do not include the superimposition of multiple facies environments (Boggs 1987). At site 5LA9187, some trench profiles exhibit fining-upward sequences, while in others the pattern is not as clear. The former include the northwestern end of Trench 1A (profiled in 2000), Trench 2A, and possibly Trench 4A (Figures 16 and 18). Some profiles contain only fine-grained overbank sediments (Trenches 1C, 2B, 2C), while in others, overbank sediments are interbedded with frequently discontinuous coarse sand and gravels (1A,

3A & 4A). These coarse materials are interpreted as channel lag deposits, and are often the result of reworking and redeposition during episodes of channel migration or incision (Boggs 1987). Channel cuts, visible in Trenches 1A, 2B, 2D, and 4A, are primary agents of erosion. These channels subsequently become in-filled with coarse, and occasionally fine, sediments (Trenches 1A, 1B, 2D, 4A).

Geologic History, Radiocarbon Ages, and Stratigraphic Relationships

The following discussion will examine the question of alluvial geochronology and the timing of sediment aggradation, erosion, and stability at 5LA9187. The discussion will utilize the available body of radiocarbon data, and will include observations on temporal and physical equivalency among stratigraphic units

Radiocarbon data have yet to be procured from Trench 1A and reliable age estimates for episodes of aggradation, erosion, and stability are not available. There are, however, several stratigraphic units in Trench 1A that appear to be stratigraphically, lithologically, and pedogenically similar to units in several other trench profiles. In Trench 1A, these include Unit I, a brown (10YR 5/3 w) clayey silt with early stage 3 carbonate development extant at 1.20 – 1.45 m below the surface (Figure 15). This unit was termed "the gray unit" during the field investigations (see Chapters 2 and 6) and was distinctive due to its fine-grained texture, gray to brown color, abundant pedogenic carbonates, including frequent nodules (stage 3), and stratigraphic position (generally at or near the bottom of the sequence). After careful examination of the radiocarbon, stable carbon isotope, organic carbon, and lithologic data, the only unit with equal similarities in color, depth, texture, and carbonate development, is Unit II in Trench 1C, a brown (10YR 5/3 w) silty clay with early stage 3 carbonates, extant between 1.20 – 1.80 cm below the surface.

The other stratigraphic units in Trench 1A that appear particularly similar to units in other trenches are Units III and V. Unit III is an olive brown (2.5Y 4/4 w) to brown (10YR 5/3 w) silt with late stage 2 carbonate development. It is extant from .90 to 1.20 m below the surface. Unit III has close lithologic, pedogenic, and stratigraphic similarities with stratigraphic units in three other trenches. These include Unit III in Trench 1C, a brown (10YR 5/3 w) fine sandy silt with stage 2 carbonates. It is extant in Trench 1C between 1.00 and 1.20 m below the surface. Unit III contained a hearth feature that yielded three AMS ages of 6800 ± 40 yr BP (Beta 158491), 6906 ± 68 yr BP (ETH 24873), and 6992 ± 64 yr BP (ETH 24872). These appear to reliably place the Unit III period of aggradation at between ca. 6800 and 7000 yr BP.

Two stratigraphic units from other backhoe trenches are quite similar to Unit III in TIC. These include Unit I in Trench IB and Unit Ib in Trench 4A. Unit I in Trench IB is a brown clayey silt (10YR 4/3 w) with stage 2 carbonate development. It is extant from 1.00 to 1.25 m below the surface. A charcoal sample from the lower portion of Unit I yielded an AMS age of 6323 ± 62 yr BP (ETH 24876). Unit Ib in Trench 4A, is a brown (10YR 5/3 w) fine sandy silt with late stage 2 to early stage 3 carbonates. It is extant from 1.10 to 1.30 cm below the surface. Finally, there are also similarities between Unit III in Trench 1C and Unit I in excavation Unit 2. Unit I is grayish brown clayey silt with stage 2 to early stage 3 carbonate development. It is extant from ca. .86 to 1.2 m below the surface. Of particular interest is the similarity in the

organic carbon content of Unit 1 in XU 2, and Unit III in Trench 1C. Both produced OC percentages of 0.52% (Table 6).

The last stratigraphic unit in Trench 1A that appears similar to units in the other backhoe trenches is Unit V, a brown (10YR 5/3 w) clayey and fine sandy silt with stage 1 carbonates. It is extant from .25 to .90 m below the surface and was coined the "popcorn" unit during the field investigations due to its distinctive soil structure (strong medium angular blocky). While this form of structure is certainly distinctive, it is by no means rare. In, and adjacent to, the site area exposures of brown to grayish brown silts with stage 1 carbonates and strong angular blocky structure are actually quite common. This is a reflection of the homogeneity in the lithology and pedogenic tendencies of alluvial source materials in this area. As a result, comparisons between Unit V at Trench 1A and units in other trenches should be made with caution and are offered here as a topic of future research rather than a reliable tool for sediment correlation. With these caveats in mind, other units with similar texture, color, carbonate development, and stratigraphic position include Unit IV in Trench 1C and Unit Vb in Trench 4A. Unit IV is a brown (10YR 5/3 w) to grayish brown (10YR 5/2 w) clayey silt with stage 1 carbonate development and strong fine angular blocky soil structure. It is extant between .60 and .90 m below the surface. Unit Vb in Trench 4A is a brown (10YR 5/2 w), clayey silt with stage 1 carbonates and strong, medium subangular blocky structure. It is present from .25 to .85 cm below the surface. A charcoal sample from Unit Vb produced an AMS age of 5535 ± 59 yr BP (ETH 24877). The radiocarbon age from Trench 4A, and the ages derived from the underlying Unit III in Trenches 1A and 1C, could place the initiation of Unit V-IV-Vb aggradation somewhere between ca. 6800 and 5500 BP. Additional dates from units not dissimilar to V-IV-Vb include 4658 ± 215 yr BP (ETH-24878) from Level 10 in XU 7 (very bottom of "popcorn" unit or very top of "gray" unit?), 717 ± 49 yr BP (ETH 24882), from Feature 8, Level 2, XU 26, and 689 ± 49 yr BP (ETH 24879) from Feature 5, Trench 4A. Additional research at 5LA9187 could potentially demonstrate correlative relationships between these ages and the timing of the "popcorn" unit deposition, particularly the termination of that deposition prior to the aggradation of the recent surface mantle.

Interpretations of Climate and Depositional History

The present body of radiocarbon data have been useful in estimating the age of vertical accretion in Trench 1C, and could contribute to a temporal context for channel incision and infilling in Trench 1A, 1B, 2D, and 4a. At Trench 1C, the AMS ages from Units I and III suggest that the 1C floodplain began to aggrade by ca. 7600 yr BP. By 6,800 years ago, Units II and III were deposited and cultural occupation resulted in the deposition of artifacts and features in the Unit III fill. In nearby Trench 1A, Unit I may also have been deposited by this time. Both Units II and III in Trench 1C contain significant amounts of pedogenic carbonates, indicative of pedogenesis and vertical transpiration of carbonates under conditions of reduced effective precipitation (cf., Holliday 1989, 1990; Reider 1990). The radiocarbon ages from 1C, ranging from ca. 7600 to 6800 BP leave little doubt that much of the aggradation and soil formation in the lower and central portion of the terrace fill occurred during the so-called "Altithermal" episodes of warm and dry climate in the early and middle Holocene (Benedict 1979; Wright 1992; Clayton et al. 1976). While certainly not constant, arid landscapes during the period from ca. 8500 and 4500 BP witnessed significant stream aggradation resulting from decreased

vegetation on valley slopes and resultant increases in sediment yield and sediment transport to valley bottoms (cf. Knox 1972, 1984; Erhart 1967). Return to more mesic conditions between episodes of "Altithermal" aridity, could have witnessed stream incision as hillslopes stabilized and sediment yield to the valley bottoms decreased (Knox 1972, 1984; Holliday 1989).

After ca. 6800 BP, vertical accretion resulted in the deposition of Units IV and V at Trench 1C, and possibly Unit III in Trench 1A. At Trench 1B, overbank deposition was initiated prior to ca. 6300 BP, and led to the aggradation of Units I – III. Sometime after 6300 BP, channel incision truncated the overbank materials in Trench 1B and possibly in Trench 4a. Channel cutting was followed by channel infilling and vertical accretion again became active by ca. 5500 BP, continuing until ca. 4600 yr BP, but not continuously. The deposition of Unit V in Trench 1A, IV in Trench 1C, and Vb in Trench 4A occurred during this period. Aggradation of these units appears to have ended sometime before ca. 700 yr BP. The final episode of overbank flooding, represented by Unit XIV in Trench 4A, and possibly Unit V in Trench 1C, Unit VII in Trench 1B, and Unit VI in Trench 1A occurred prior to ca. 700 BP. A recent mantle of slopewash and eolian silt was the last significant depositional event in the immediate site area . Alluvial deposition along the unnamed arroyo in historic times has been primarily limited to low-lying surfaces adjacent to the main channel.

Concluding Remarks

Geoarchaeological investigations at site 5LA9187 centered on the examination and interpretation of sediments and soils exposed along the walls of four principal backhoe trenches. These were excavated in the fill of two alluvial terraces associated with significant periods of local valley aggradation from the late-early to late Holocene. Terrace fill sediments consist of predominately fine-grained overbank deposits and more coarse-grained channel materials. The former are responsible for vertical accretion and generally dominate the stratigraphic sequences. The coarser sand and gravels form lateral accretion sediments. In a number of trenches these include channel lag and possible point bar/natural levee deposits that are arranged below overbank sediments in fining upward sequences typical of meandering stream environments. More frequently, the coarser sands and gravels are apparently channel lag sediments deposited during episodes of lateral channel migration and/or incision. Some sandy deposits may have originated as upper point bar or natural levee deposits that were subsequently reworked by channel migration.

The investigations at 5LA9187 included interpretation of the basic stratigraphic and pedogenic composition of terrace fill sediments, a reconstruction of former sedimentary depositional environments in the site area, the examination of temporal and morphological similarities between individual stratigraphic units, and the discussion of local geochronologic events. Sources of interpretive data included soil organic carbon and stable carbon isotope values. The former illustrate that the site generally follows expected patterns in the vertical distribution of soil organic carbon, while the $\delta^{13}C$ analyses proved inconclusive as a potentially useful proxy for local paleoenvironmental conditions.

Temporal context for the alluvial deposits was provided by the procurement of 12 radiocarbon ages. These were recovered from archaeological hearth and pit features, and from

charcoal naturally distributed within the terrace fill. Additional charcoal samples were collected but proved unreliable before or during pretreatment due to insufficient amounts of measurable carbon or ambiguous stratigraphic context.

Apparently reliable radiocarbon ages from fine-grained overbank sediments place significant vertical accretion episodes between ca. 7600 – 6300 BP, and ca. 5500 – 700 BP. Many of the extant floodplain deposits accumulated under conditions of middle Holocene aridity, as did many of the soil-forming episodes represented in the various trench profiles. Episodes of channel migration and incision are most strongly evident from ca. 6300 to 5500 BP, but may have continued periodically until ca. 700 BP.

In all, 5LA9187 proved a deceptively complex alluvial depositional environment. The extant stratigraphic and pedogenic records in the site area are the product of multiple episodes of former floodplain aggradation and intervening periods of landscape stability and soil formation. The interpretation of previous pedogenic conditions and active depositional environments was hampered by the apparent erosional truncation of most soil profiles and the resultant loss of former A horizons. Vertical stratigraphic sequences and the correlation of former floodplain deposits were further complicated by episodes of lateral stream migration and stream incision, which initiated the truncation of many stratigraphic units and resulted in a generally complicated stratigraphic sequence. Understanding the dynamics of this environment required the incorporation of multiple lines of sedimentary and pedologic evidence.

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5. TRENCH AND SURFACE ARTIFACT ANALYSES

Stanley A. Ahler

Several artifacts were discovered at the Barnes site during the summer 2000 field program that spurred interest in understanding possible Paleoindian age components at the location. Artifacts of note occurred both in the substantial surface collections as well as at depth in Trench A opened in 2000 (see Chapter 4, herein). In this chapter, I discuss all of these specimens in greater detail, along with the fluted Folsom point from the site, and assess the evidence for a Paleoindian component as documented in the physical remains from the site in trench and surface contexts. The significance of this assessment is now overshadowed to a great degree by the current knowledge that the uppermost 1.5 meters or so of site sediment contains no deposits that are Paleoindian in age (see Table 5 and discussion by Dave Kuehn in Chapter 4). Nonetheless, a close examination of the artifacts in question and contextual information may prove enlightening regarding how to approach the study of discoveries such as the Barnes site in the future.

Artifacts in Trench A, 2000

During fall of 2000 Dave Kuehn collected several artifacts from the floor of backhoe Trench A, at a depth of ca. 94 cm and at a location just north of our excavation Unit 1/2 test pit shown in Figure 5 (Chapter 2). These artifacts were described at the time as having originated in a buried A soil horizon. Because they figured heavily in the decision to return to the site in 2001, I examined them in greater detail for the present study.

Three cataloged specimens are recorded as heat altered or fire-cracked rock (cataloged as Field Specimen(s) 210 or FS-210). Two of these specimens are definite artifacts. One is a thermally discolored piece of sandstone (13.3 g) with angular fracture faces, and the second is a small limestone piece (3.0 g) not altered in color but with blocky, angular fracture surfaces. The third specimen has a rounded shape and I would classify it as a natural limestone pebble.

Two chipped stone artifacts were also found in the same approximate location. The smaller specimen (FS-209; 1.2 g) is a simple cortical flake with a steeply retouched or crushed distal margin. It is dark red and thermally altered, with part of the dorsal surface spalled off from heat. It probably is made of yellow chert or yellow Black Forest silicified wood. In color, raw material, and technology, this artifact is little different from perhaps 50 or more specimens in the site surface collection.

The largest artifact from the trench (FS-208, 27.6 g) is a fragment of a freehand percussion core, one thin edge of which has been used as a cutting or slicing tool. This core is made of a very unusual, distinctive fine-grained chert, deep reddish gray in color. Edges are translucent to a thickness of about 1 mm, and translucent areas appear to contain myriad dark, dendritic inclusions. Under higher magnification, the rock appears to be comprised of deep reddish blotches and the smaller, less diffuse dendritic speckles. The core retains a small area of cortex that is a very distinctive, abrasive, rough rind that has not been subjected to geologic

transport. The core is slightly patinated or thermally altered, exhibiting a faint grayish haze on one end.

Because the stone in this core is so distinctive, I examined the controlled surface collection in detail for fragments of the same piece of rock. I found three surface artifacts that were almost certainly struck from the same core. The largest (FS-6; 5.3 g) is a complex freehand percussion flake that retains rough, granular cortex in its platform and bulbar area; this flake has utilization damage along one edge. The second (FS-256; 1.1 g) is a complex, non-cortical flake fragment that also exhibits utilization damage along one margin. The third (FS-449; 0.1 g) is a small simple flake that does not appear to have been used. I also briefly examined part but not all of the excavated collection for additional examples of this particular stone. I found at least 14 excavated flakes that were struck from the same core, these being from Levels 1 and 2 of XU33, Level 1 of XU3, Level 1 of XU1, Level 1 of XU2, and Level 1 of XU5 (Catalog Nos. 1005, 1011, 1015, 1166, 1319, 1327, 1328). Together these occur within about two meters to ten meters, horizontally, from the location of the core in the backhoe trench. The widespread distribution of fragments of a single stone nodule within both the surface collection as well as in the uppermost artifact-bearing excavated horizon at the site leaves no doubt that Specimen FS-208 (and its companions FS-209 and FS-210) in Trench A are also part of the Late Prehistoric component. These specimens almost certainly found their way to a depth of nearly a meter through post-depositional disturbance processes (see discussion of excavation and stratigraphy in excavation Unit 1/2 in Chapter 6).

Paleoindian Surface Artifacts

I examined chipped stone materials in the controlled surface collection in some detail with particular attention to the Folsom point and other possible or purported Paleoindian age specimens. The collection was first examined in detail for artifacts technologically indicative of Folsom derivation such as channel flakes, fluted point preform fragments, fragments of ultrathin bifaces, and thinning flakes removed from ultrathin bifaces. I found none in the collection. I then looked carefully at several artifacts that had been designated by other project personnel as likely or possibly Paleoindian in age. One such specimen was a proximal biface fragment (FS-66) made of fine-grained brown quartzite designated as a possible Plano point. This is a bilaterally asymmetrical, bifacial cutting tool that exhibits use-wear under 10X magnification along one lateral margin. Its asymmetrical basal form is common in many Plains Village and other Late Prehistoric age collections (e.g., Wood 1967:Figure 5A-D), and such tools were probably used while hafted in a bone or wood handle along one of the long edges. This artifact is almost certainly part of the Late Prehistoric assemblage at the Barnes site. A second artifact also designated as a possible Plano point (FS-156) is the distal end of a pointed biface made of speckled gray quartzite. Under magnification, it exhibits pronounced rounding and dulling of one lateral edge, and it also probably functioned as a cutting tool. While its form is less diagnostic, temporally, it lacks highly patterned pressure flaking characteristic of Plano points, and it is also very likely part of the Late Prehistoric assemblage at Barnes.

I examined two artifacts with features similar to polyhedral blades (FS-204, FS-205). Each is made of fine-grained yellow chert, and the two specimens may have been struck from the same core. The best-described blades with certain Paleoindian age are from Clovis contexts in

the Southern Plains (Collins 1999). The two Barnes specimens lack the size, length, curvature, and refined platform features characteristic of Clovis blades. One (FS-204) is a longitudinally split, elongated flake fragment lacking a platform and of indeterminate original length and width. It may be a fragment of a blade or a blade-like flake (lacking the >2:1 length:width definition for blades). The second (FS-205) does exhibit three previous parallel dorsal scars, but has a l:w ratio of about 1.6:1, and has a large unprepared platform, very unlike the small ground and blunted platforms associated with Clovis technology. These artifacts are very probably part of the Late Prehistoric assemblage at the Barnes site.

Several end scrapers within the surface collection can be identified as having a spurred or angular corner at one extremity of the working edge (FS Nos 13, 31, 166, 171, 579) and, therefore, possibly as Paleoindian in age based on the occurrence of scrapers with this form in early sites on the High Plains (Irwin and Wormington 1970). Altogether, more than 40 end scrapers occur at the site. The morphology and relative frequency of specimens with angular corners, taken within the context of the total scraper collection, gives little cause to consider these specimens to be separate from the main Late Prehistoric assemblage in the site.

I examined the Folsom point fragment from the site surface (FS-16) (the find spot is shown on Figure 5, Chapter 2) in detail with the aid of a binocular microscope. The fragment is part of the distal end (perhaps originally the distal one-half) of a finished Folsom point (Figure 19). The point tip may have been resharpened, but this is not particularly clear because the extreme distal end of the specimen is now missing. The extant fragment originally broke from the remainder of the point in a lateral snap that bears evidence of having occurred during impact. This evidence is in the form of small, distally directed flake removals that originate at the transverse fracture plane (left facial view in Figure 19). Therefore, this artifact once was a sizeable fragment (perhaps originally 30 mm in length) of the distal end of a finished point – a piece likely to have been fractured and lost at a hunting or kill location.

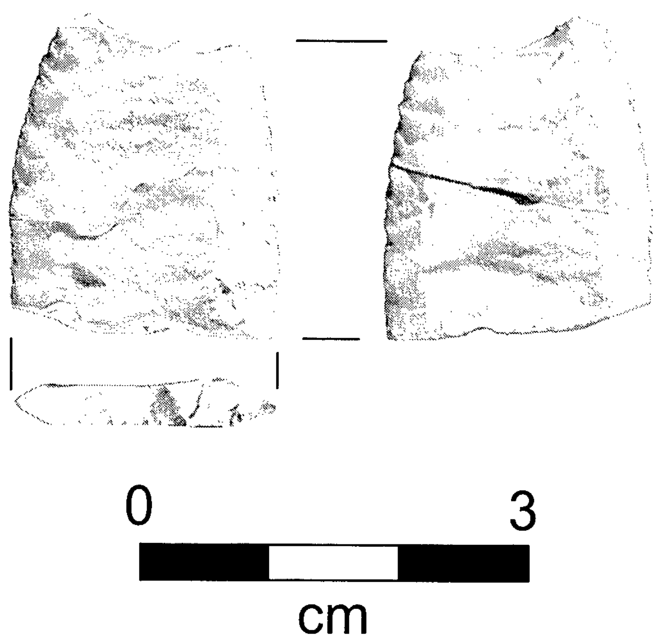

Figure 19. Folsom point fragment, FS-16, from the surface of the Barnes site, 5LA9187.

Subsequent to its use and the transverse impact fracture, the specimen experienced substantial alteration, and this is most apparent at the microscopic level. Both flaked lateral margins are distinctly microflaked (randomly), blunted, and rounded. The margins of the snap fracture are similarly and heavily microflaked (visible in Figure 19), blunted, and rounded. This modification can generally be called "irregular edge damage." All surfaces of the point are glossy (including the transverse fracture), as if polished slightly by wind or water

abrasion. Most significantly, small localized spots on several flake arrises and ridges on both faces are faceted in a very distinctive, planar fashion and are highly polished, indicating contact and movement against another very hard object of small dimension. A unidirectional contact motion can be discerned in several of these "spot polish" areas. This spot polish is thought to result from very high pressure, point contact between the artifact and another object of convex form and similar hardness (see Young and Bamforth 1990:407). These spot-polish facets occur at several places on both faces of the Folsom point, near and far from the tip, on flake ridges and on slightly elevated areas within both channel flake scars. About 30 discrete areas of spot polish are observable, roughly equally distributed on each face of the artifact.

Spot polish or point-contact polish is sometimes associated with contact between a hard flintknapping percussor and a stone tool surface (see Keeley 1980:28; Dumont 1987:Figure 12.8). It is also observed consistently on tools, blanks, or raw material pieces thought to have been humanly transported some distance from a stone source area, apparently deriving from artifact-to-artifact contact in the carrying bag (see Ahler 1997 and Young and Bamforth 1990:407). In the latter case, spot polish usually co-occurs with irregular edge damage. Two explanations seem possible for the combination of irregular edge damage, general surface gloss, and extensive spot-polish wear on the Folsom artifact. One is derivation from extensive, long-term transport by humans during which the artifact frequently made contact with other stone artifact. The second is through a natural stream transport event in a gravel-rich environment during which the artifact came in contact with natural stone clasts. The spot polish on the Folsom point is unusual, in that many of the occurrences exhibit absolutely planar faceting or truncation of surfaces and arrises. This indicates an extremely rigid contact situation, in which the angle between artifact and external object remained invariant while lateral motion was occurring. The most likely context for this to have occurred, all things considered, is probably within a natural rather than a cultural transport situation. The most readily available local context for such wear is within the channel of Sediment Package 4 that crops out at the site surface only a few meters from the find spot for the Folsom point (SP 4 in Figure 5, Chapter 2). One can also imagine this sort of spot polish as having been created through solifluction or cryoturbation, or during rock-to-rock contact in a soil movement situation, rather than in a stream flow environment.

Sometime during its history, and after the impact fracture, the Folsom point fragment was heated sufficiently to create internal potlids and stress cracks. Subsequent to heating, the artifact broke into at least three pieces. Two conjoinable pieces (Figure 19) were found very near each other on the site surface. The distal-most piece(s) has not been found but is probably nearby. The fractures through the specimen that occurred after heating or burning are microscopically sharp and fresh, and exhibit no post-fracture alteration.

A very plausible history for this artifact would begin with its use, fracture, and loss by a Folsom hunter during a game encounter at some location upstream and up-arroyo from the Barnes site. Subsequently, it was transported downstream in the gravel-filled bedload of SP4, the dense channel gravel unit. During or after this transport, it was severely altered through contact with limestone gravels in the arroyo channel. Most of the spot polish on the artifact may have developed while it was imbedded in the gravel deposit, subject to forces from freeze-thaw action. Sometime during the last few thousand years, this gravel was eroded and deflated, and

the specimen was exposed on the ground surface. Late Prehistoric people who camped on the site noticed this specimen, picked it up, perhaps used it briefly for some purpose, and tossed it into their campfire, as they tended to do with many of the chipped stone pieces they left at the site. Most recently, something crushed the artifact (a tank?), breaking it into three or more pieces. In 2000, crew members Kelli Barnes and Mike Chidley found and collected two of those pieces.

While other specific histories could be hypothesized for this specimen, all must include a period when it was transported in a random contact environment, thereby accounting for the distinctive micro-wear on the specimen. In any scenario that includes evidence of post-fracture alteration of the artifact, it is improbable that the find spot for the Folsom point on the Barnes site was near the place it was lost or discarded by a Folsom person. The conclusion is that this artifact is only fortuitously associated with the site and that it does not reflect in situ Folsom activity at this location.

The Folsom point is identified as having been made of White River Group Silicate (Hoard et al. 1993), the best known source for which is at the quarries atop Flattop Butte in northeastern Colorado about 380 km from the Barnes site. Material from these quarries is also known as Flattop chalcedony, and this stone was relatively widely distributed in Folsom sites in the central Great Plains. For example, Hofman (1994) reports this material in Folsom points from Kansas, and Flattop chalcedony is identified in two of the 17 (LeTourneau 2000:Appendix B) or 23 (Meltzer et al. 2002) Folsom points from the Folsom type site in New Mexico, about 75 km due south of the Barnes site. When fieldwork was ongoing, Jack Hofman suggested that one might look particularly closely at the composition and distribution of Flattop chalcedony artifacts in the Barnes site, knowing that the Folsom point was made of this material, to potentially identify other Folsom artifacts or to delineate a possible Folsom concentration within the general surface assemblage. I conducted such a study, mostly to follow up on the idea that at least some Flattop specimens in the collection in addition to the fluted point might also be Folsom in origin (even if transported).

Table 8 lists data on all certain or probable Flattop chalcedony artifacts in the surface collection. This small sample exhibits some diversity in transport history and use history. Three specimens are diagnostic of the main Late Prehistoric occupation at the site (two arrowpoints and one flared-base drill), and these are distinctive on two counts: they are all relatively small (see weights) and none of them exhibits any form of transport wear (irregular edge damage, spot polish, overall gloss). In contrast, all but one of the other Flattop chalcedony specimens (excluding the Folsom point) are relatively large in size and show evidence of transport prior to deposition at the site. In several cases, there is evidence of transport damage followed by use, this in the form of retouch or thermal fracture that occurred subsequent to transport. Curiously, none of these artifacts exhibits an overall surface gloss similar to the Folsom fluted point. All exhibit relatively few occurrences of spot polish compared to the Folsom point. Also, there are extremely few instances of spot polish with a planar facet or truncation in the polished area. The evidence strongly suggests that nearly all of these Flattop specimens were originally created elsewhere and were transported in retouched flake or flake blank form to the site. The transport wear on these specimens differs qualitatively from that on the Folsom point, and probably derives from human transport rather than natural transport. It is likely that these are Late

Prehistoric artifacts, brought to the site in the form of blanks for purposes of tool production in the camp at Barnes.

Table 8. Summary of observations relevant to artifact age and transport history for Flattop chalcedony specimens in the surface collection from the Barnes site, 5LA9187.

Age	FS No.	Artifact Type	Wt. g	N Spot Polish Dorsal	N Spot Polish Ventral	Irregular Edge Damage	Interpretation
Late Prehistoric Diagnostic							
	89	arrowpoint	0.5	0	0	none	recent manufacture
	230	arrowpoint	0.8	0	0	none	recent manufacture
	162	drill	1.0	0	0	none	recent manufacture
Folsom Diagnostic							
	16	Folsom point fragment	2.9	15	15	pronounced	manufactured > used > broken > transported > recently burned
Nondiagnostic							
	59	retouched (?) flake	3.6	4	3	severe	created > transported, not used
	49	retouched flake	19.5	7	3	severe	created > retouched > transported, not used
	428	retouched chunk	13.4	2	1	none	recent manufacture
	15	ret. flake / end scraper	9.8	3	5	pronounced	created > transported > recently modified
	151	end scraper	10.7	0	5	none	created > transported > recently modified
	519	flake	8.6	3	2	severe	created > transported
	158	retouched flake blade fragment	4.6	3	3	pronounced	created > retouched > transported > recently burned
	211	retouched flake edge fragment	0.5	1	1	pronounced	created > retouched > transported > recently burned
	420	retouched (?) flake	5.3	3	1	severe	created > transported > recently burned
	159	retouched flake fragment	4.0	0	1	pronounced	created > retouched > transported > recently broken

Summary

The surface collection from Barnes contains only a single artifact that can be considered Paleoindian in age, this being a Folsom point fragment. A variety of evidence, mostly in the form of use-wear, but including comparative data from other artifacts made of the same raw material, indicates that the Folsom point is an isolated find only fortuitously associated with the prominent Late Prehistoric age occupation at the Barnes site. In addition, the artifacts found at depth in backhoe Trench A in 2000 are demonstrably Late Prehistoric in age. All of the evidence

from the 2000 field season that appeared at first glance to indicate presence of Folsom or other Paleoindian components at the Barnes site has, upon study, proven to be spurious.

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6. HAND EXCAVATION RESULTS

Stanley A. Ahler

In this chapter I present and discuss the results of hand excavations at various locations within the Barnes site. Stratigraphic profiles are provided for nearly all hand excavation units. With the exception of the profile drawings for excavation Units 1 and 2, that bear notations provided by Dave Kuehn, descriptive labeling of the profiles is non-technical in nature and conforms to field notes taken in some cases by more than one individual. Munsell soil colors indicated on the profiles are in moist condition. References to carbonate presence, absence, or abundance on the profile drawings refer to visible carbonate filaments or nodules. Tests with weak HCl indicate that virtually all excavated sediments were very carbonate-rich, regardless of carbonate visibility in the unit profiles.

Count, weight, and/or presence-absence data (in samples where present) are listed by excavation level for natural and cultural materials recovered from each unit. All artifacts found in contexts deeper than the third excavation level (ca. 25-30 cm) below surface are discussed in greater detail. Artifacts in levels 1-3 reflect almost exclusively the Late Prehistoric age component at the site. Materials occurring in the uppermost three excavation levels and likely to be Late Prehistoric in age are emphasized by shading in the data tables. Materials from excavation levels subjected to only partial recovery (applying waterscreening but ignoring dryscreening) are shown in italics in the data tables. Although Late Prehistoric age artifacts are partially inventoried here (artifact inventory data are not provided for the Feature 5 excavation area), such artifacts are to be analyzed and discussed in detail in a separate report. In the data tables that follow, counts of flaking debris consist of actual counts of size grade G1-G3 flakes plus the estimated number of G4 flakes in a square based on the count of such specimens in the waterscreen sample multiplied by a factor of 9 (the waterscreen sample is 1/9th of each excavation level by area and volume). For convenience, Figure 5 from Chapter 2 is repeated here as Figure 20. The discussion that follows is organized by subarea within the site, determined in part by the five "sediment packages" discussed in Chapter 2 and as shown on Figure 20.

Deep Tests Near Trench 1A and in SP2

Five test unit sets reached or penetrated the gray unit that formed the lower part of Sediment Package 2 as identified along the central portion of backhoe Trench 1A. At the start of fieldwork, we expected artifacts to occur on or close to the upper surface of the gray unit, and this contact and the deposits below it were the targets in all of these tests.

Units 1, 2, and 33

These units were placed as close as feasible to the original deep artifact find spot within backhoe Trench A (Figure 20). Units 1 and 2 were excavated with full recovery through 13 arbitrary levels below surface, and Unit 33, adjacent to Unit 1, was excavated through seven levels, with partial recovery in levels 5, 6, and 7, for purposes of access at depth. Figure 21 shows excavation profiles for Units 1 and 2 ,and Tables 9 and 10 provide artifact and material

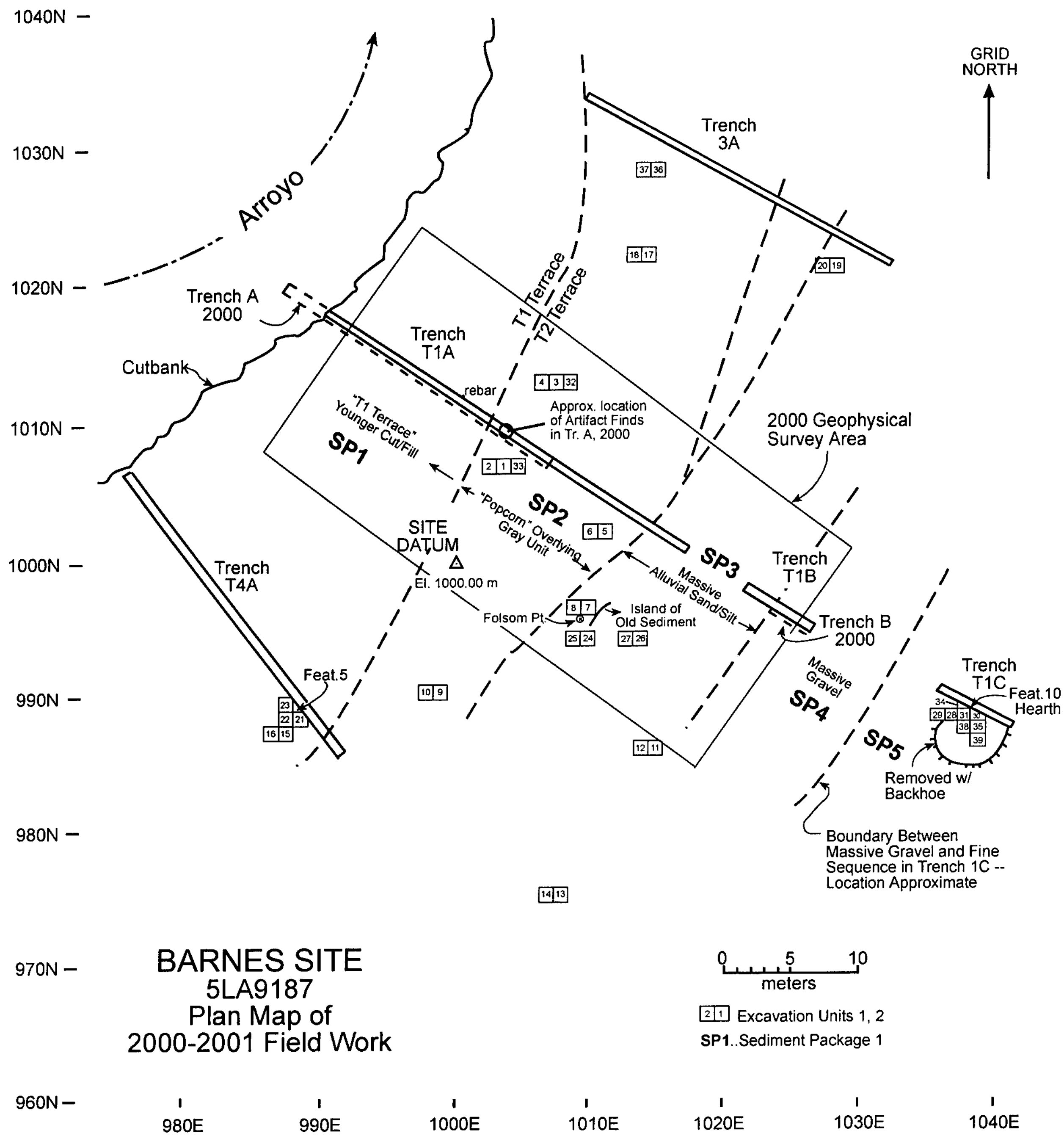


Figure 20. Plan map of the central part of the Barnes site (5LA9187) showing locations of trenches, hand excavations, site datum, Folsom point find spot, and approximate spatial extent of sediment packages.

content information for all of these test units. The west wall of Unit 2, containing a typical section for this location free of apparent rodent disturbance, was the locus for special sampling for purposes of organic carbon analysis and stable isotope studies (discussed in Chapter 4) as well as magnetic susceptibility tests (De Vore 2002, Appendix B, herein). Dave Kuehn examined the profiles in these test units in some detail, and consequently, was able to apply the

detailed soil unit (S1, S2, etc.), soil horizon (A/Bw, Bkb1, etc.), and stratigraphic unit (I, II, etc.) labeling system he used in nearby backhoe trenches to this excavation. His designations are indicated in italics on the profile drawings (Figure 21), along with what is otherwise routine and less technical descriptive information about sediments and stratigraphy.

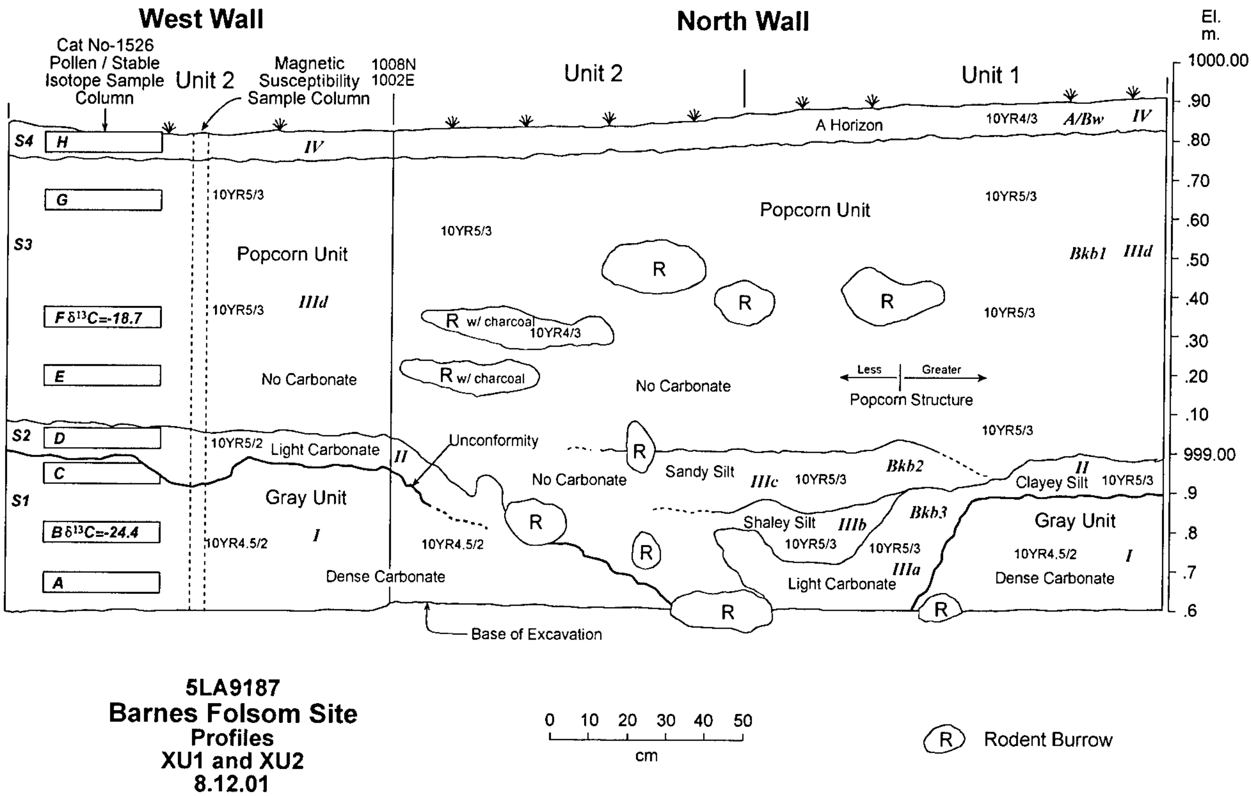


Figure 21. Profile drawings for excavation Units 1 and 2 at the Barnes site, 5LA9187.

Excavations here penetrated an almost imperceptible A horizon, a thick deposit of the "popcorn" unit (which is a lighter brown clayey silt that weathers or picks to a distinctive blocky subangular structure with abundant small peds), a thin layer with notably increased carbonates, and the massive, carbonate-rich basal "gray unit" that was the target of excavation. In the profiles it appeared that a distinct unconformity marked the upper surface of the gray unit, and Dave Kuehn's soil designations (S1, S2, etc.) indicate that four different sediment units separated by unconformities actually occur here. Snails are abundant throughout the entire stratigraphic sequence (Table 9), and pedogenic carbonate nodules appear in level 10 (coinciding with highest appearance of carbonate in the profile drawing) and remain abundant to the base of excavation. The north wall profile is notable for two things: many rodent burrows, and a cut/fill unit (III) that removed part of the lower two units and continued into the floor of the excavation. The south and east walls of the test pit closely resembled the west wall, and contained no rodent burrows or indication of the cut/fill channel. I examined the nearest wall of nearby backhoe Trench 1A (less than two meters away) for presence of the channel cut, but could not see it. Rodent burrows are abundant in the south wall, starting at about 50 cm below surface, and extend into the floor of the excavation and into the gray unit at a depth of 1.3 m below surface.

Table 9. Quantitative data for artifacts and materials by level in excavation Units 1 and 2 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 1											Unit 2										
LEVEL	Flakes G1-4	Tools	Sherds G1-3	FCR	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	FCR	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)
1	52	2	27	1	1	1	1	149	61	1	1	55		25		3			212	295	
2			1			3		64	24		2	9	1	1		1	2		98	104	
3						2		63	29		3						1		64	63	
4						2		51	28		4	9					1		78	54	
5						2		38	188		5	1					1		50	105	
6						1		44	248		6			2			2	5	128	272	
7						2		84	531		7						1		60	169	
8						2		120	277		8						2		50	89	
9	1					2	1	36	138		9			1			2		25	31	
10						2		40	130	38	10						2		25	83	3
11						2		35	55	51	11			2			2		87	70	11
12						1		56	42	48	12						1		59	32	15
13						1		32	12	57	13							1	25	31	9
Tot	53	2	28	1	1	23	2	812	1763	195	Tot	74	1	31		4	17	6	961	1398	38

Table 10. Quantitative data for artifacts and materials by level in excavation Units 32 and 33 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 32 (Next to Units 3&4)									Unit 33 (Next to Units 1&2)							
LEVEL	Flakes G1-4	Tools	FCR	Unburn Bone G1-5	Burn Bone G1-5	Snails P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	Burn Bone G1-5	Residue (g)	Natural Rock (g)	Pedog. Carb (g)
1	63	1	1	4	7		215	359	1	30	1	5	2	133	155	3
2							10	2	2	71		7		81	86	
3						1	1	1	3	28				97	60	
4							*5*		4					48	59	
5							*1*		*5*					*28*	*2*	
6							*14*	*3*	*6*					*26*	*9*	
7							*47*	*18*	*7*							
8							*101*	*43*								
Tot	63	1	1	4	7	1	394	426	Tot	129	1	12	2	413	371	3

During excavation, it was extremely difficult to see the rodent disturbance that occurred in this area. Five pieces of charcoal had been plotted in level 6 of Unit 2 (Table 9) before a large sherd was discovered and rodent burrows were eventually detected. Sherds and flakes were relatively abundant in the uppermost excavation levels at this location, and sherds occurred as deep as level 11 in Unit 2. Given the high degree of rodent disturbance visible in profiles, it is

reasonable to assume that all sherds recovered below level 3 in excavation, as well as all flakes at similar depths, reached their way into those contexts via rodent burrows. This is confirmed for one large plotted sherd that was determined by excavators to be in a burrow. All other deep flakes and sherds were discovered on the screens or were found during sorting in the lab.

Artifacts in deep contexts (Table 9) can be described in greater detail. All of the sherds are very similar in color and paste, and could derive from a single vessel. The large, G1 sherd in level 6 in Unit 2 provides the best information about appearance and size. This sherd is 6.6 mm thick, has a smoothed interior, and what appears to be smoothed-over, crossed cord-roughening as an exterior surface treatment. Temper consists of very coarse sand, composed predominantly of quartz, with temper making up an estimated 50 to 60% of the volume of the paste. Temper is the same in all five deep sherds in Unit 2. The second sherd from level 6 is an eroded G3 specimen with apparent cord-roughened exterior surface treatment. The level 9 specimen is a G3 fragment lacking interior and exterior surfaces. The two sherds from level 11 are 4.0 and 5.5 mm thick and have plain and apparent cord-roughened exterior surface treatments, respectively. All of these sherds resemble very closely pottery in the surface collection and are presumed to be part of the main Late Prehistoric age component at the site.

Three flakes occur in deeper contexts. The specimen in Unit 2, level 4 is a single G4 flake (= estimated total of 9 flakes in the level); it is a non-cortical, sharpening flake of yellow chert that is probably Black Forest silicified wood. The specimen in Unit 2, level 5 is a burned G3 shatter fragment made of unidentifiable variegated chert or chalcedony. The specimen in Unit 1, level 9 is a G3 burned red chert shatter fragment, perhaps originally a yellow chert. Burned chipped stone artifacts are common in the near-surface Late Prehistoric component, and none of these specimens is out of place in that assemblage. Given the intrusive pottery in Unit 2, I interpret all of these specimens to be intrusive, as well. Given that Units 1, 2, and 33 are only 2-3 meters horizontally from the deep artifact discoveries in Trench A, and that the north face of the test pit closest to the trench is highly rodent disturbed, it is quite reasonable to conclude that the artifacts found in Trench A were intrusive from the Late Prehistoric component, as well. Other evidence discussed in Chapter 5 also strongly points to this conclusion.

The Late Prehistoric component is well represented in Units 1, 2, and 33 (Tables 9 and 10). Sherds and flakes are concentrated in the uppermost excavation level in Units 1 and 2 and are more evenly distributed in the uppermost three levels in Unit 33. A few fragments of burned bone occur in each unit, and one piece of FCR was recovered.

Units 3, 4, and 32

This is the deepest test unit complex in the site, reaching nearly two meters below surface and located about four meters northeast of the find spot for deep artifacts in Trench A. Tests at this location were designed to expose the upper surface of the possible paleosol and penetrate underlying deposits. Profiles of the north and west walls of Units 3 and 4 are shown in Figure 22, and data regarding recovered artifacts and materials are displayed in Tables 10 and 11.

Units 3 and 4 were excavated in 20 arbitrary excavation levels. At 90-100 cm below surface, the highly irregular, abrupt boundary of the gray unit was encountered, apparently at an

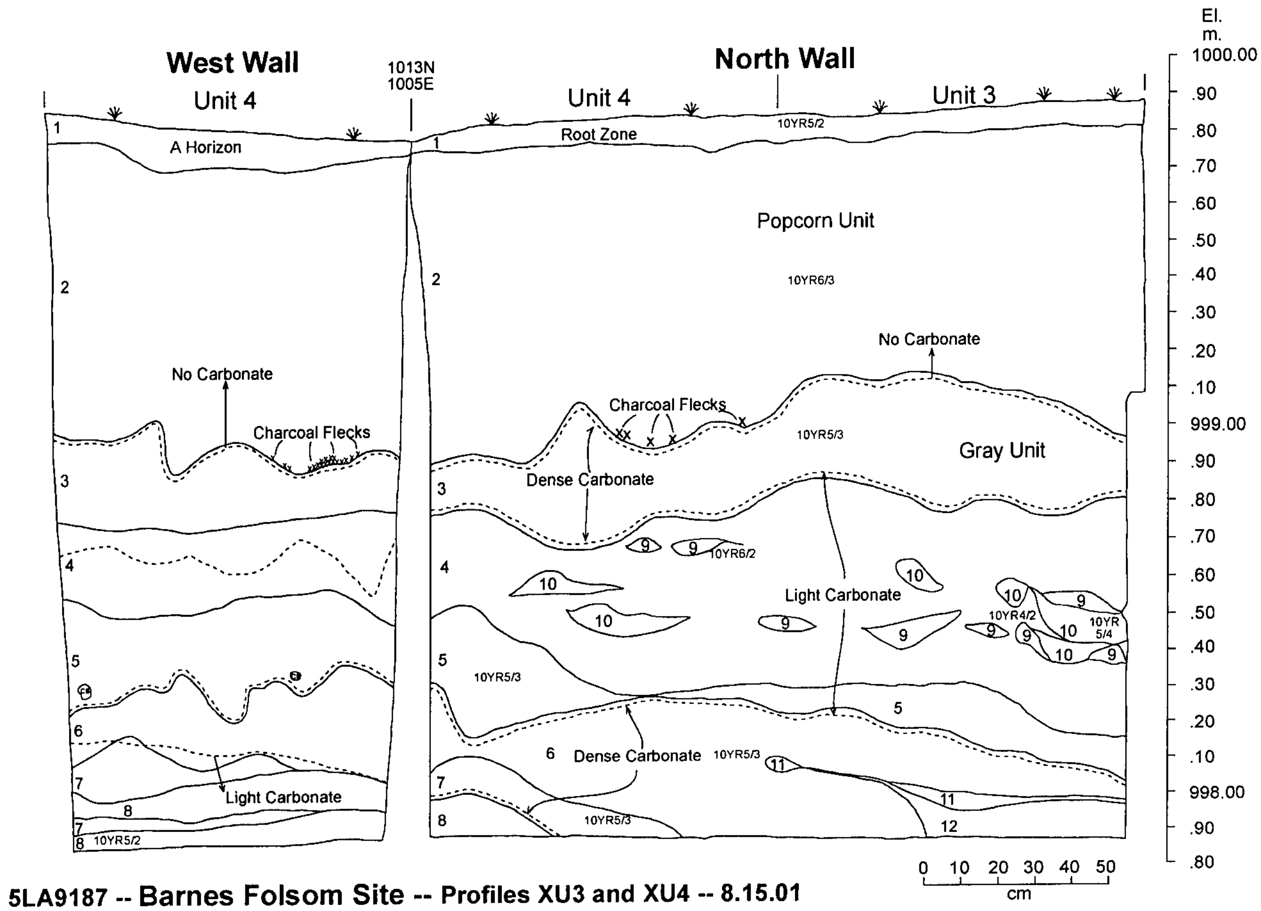


Figure 22. Profile drawings for excavation Units 1 and 2 at the Barnes site, 5LA9187.

Key to stratigraphy in Figure 21, Units 3 and 4:

1. clayey silt with a few angular pebbles; A horizon.
2. silty clay with rare subangular rounded pebbles; large, blocky peds; occasional charcoal flecks near contact with unit 3, below.
3. silty clay with almost no clasts; high amount of nodular carbonate and some large thread carbonates; some small blocky peds (gray unit).
4. silty clay with rare subangular tiny pebbles; occasional nodular carbonate; minimal small blocky peds.
5. silty clay with almost no clasts except clay smears; occasional nodular carbonate; minimal small blocky peds.
6. silty clay with almost no clasts; heavy small thread carbonates grading to occasional thready carbonates; no visible structure.
7. silty clay with subangular to angular tabular large pebbles with occasional horizontal orientations; occasional small thready carbonates; no visible structure.
8. sandy clay with subangular small and medium pebbles oriented horizontally; occasional nodular and small thready carbonates; no visible structure; alluvial deposition.
9. clayey sand with occasional subrounded pebbles; no carbonates; crumbly, clast-supported structure occurring as small lenses in unit 4; probable alluvial deposition.
10. sandy clay with no clasts; rare nodular carbonates; minimal small blocky peds; occurs as small lenses in unit 4; probable alluvial deposition.
11. silty clay with no clasts; occasional small thready carbonates; no visible structure; occurs as small lenses in unit 6; probable alluvial deposition. 2.5YR 6/4
12. same as unit 6 except finer grained and fewer small thready carbonates. 2.5YR 5/3

Table 11. Quantitative data for artifacts and materials by level in excavation Units 3 and 4 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 3										Unit 4						
LEVEL	Flakes G1-4	Tools	FCR	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)	LEVEL	Flakes G1-4	Burn Bone G1-5	Snails P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)
1	28	1	1	1	1		123	225	1	1	40	3		123	232	7
2		1			1		16	1		2	27		1	61	42	
3					1		3	42		3			2	39	87	
4					1		37	47		4			1	34	32	
5					3		23	11		5			1	16	12	
6					1		14	11		6			2	20	14	
7					2		39	127		7			1	37	93	
8					1		53	49		8			2	21	53	
9					2		53	39	10	9			2	13	28	1
10					2		14	10	2	10			2	20	46	6
11					1	1	42	9	52	11			2	31	27	
12					2	1	59	13	98	12			2	33	39	44
13					2		113	65	131	13			2	110	28	78
14					2	1	135	41	245	14			2	46	78	105
15					2	1	130	17	151	15			2	94	147	179
16					2	1	211	34	184	16			2	75	147	188
17					2	1	114	28	116	17			2	98	168	33
18					1		10	8	10	18			2	95	383	5
19					1		37	76		19			2	131	1316	13
20					2		9	100		20			2	112	4411	9
Tot	28	2	1	1	32	6	1235	953	1000	Tot	67	3	34	1209	7383	668

unconformity. Pedogenic carbonates also appear abruptly in association with the gray unit and continue to within 10-20 cm of the base of the excavation (Figure 22, Table 11). At approximately 30-40 below the upper surface of the gray unit, the sediments become quite complex, exhibiting preserved alluvial structure represented by small lenses of clayey sand and sandy clay within a more massive body of silty clay. Visible carbonates diminish in this area then appear more abundant with greater depth, while recovered carbonates (Table 11) appear fairly continuous in density through this zone. Charcoal flecks were documented in the profiles just above the upper contact surface of the gray unit, and charcoal was recovered in excavation in the lower meter of excavation, within the lower part of the gray unit and deeper. Several species of terrestrial snails were recovered, and snails were abundant throughout the entire two-meter sequence.

The only artifact recovered at depth in Units 3 and 4 was a single tiny (G5) red glass bead that was noticed lying on the floor of Unit 4 at the base of level 17 (el. 998.20 m). Excavators speculated that this artifact may have fallen from the nearby ground surface. Late Prehistoric artifacts were confined to the two uppermost excavation levels and were concentrated near the

present surface. These are comprised mostly of flakes, with a few stone tools, pieces of FCR, burned, and unburned bone (Tables 10 and 11). Sherds were absent at this location.

Units 5 and 6

This test unit pair was located about nine meters upslope from Units 1 and 2 along the same side of Trench 1A (Figure 20). This pair was placed about two meters southwest of the trench, in close proximity to a place where charcoal was observed in the trench wall and floor. The objective was to reach and penetrate the upper surface of the gray unit and to collect dateable charcoal, if such was to be found. Profiles for Units 5 and 6 are shown in Figure 23 and quantitative data for materials encountered in excavation are provided in Table 12.

Excavation occurred in nine arbitrary levels. Excavation penetrated a thin A horizon and 15-20 cm of structureless, very compact sediment that was interpreted as a tank compression zone. Below this was the typical clayey silt popcorn unit. The irregular, unconformable upper

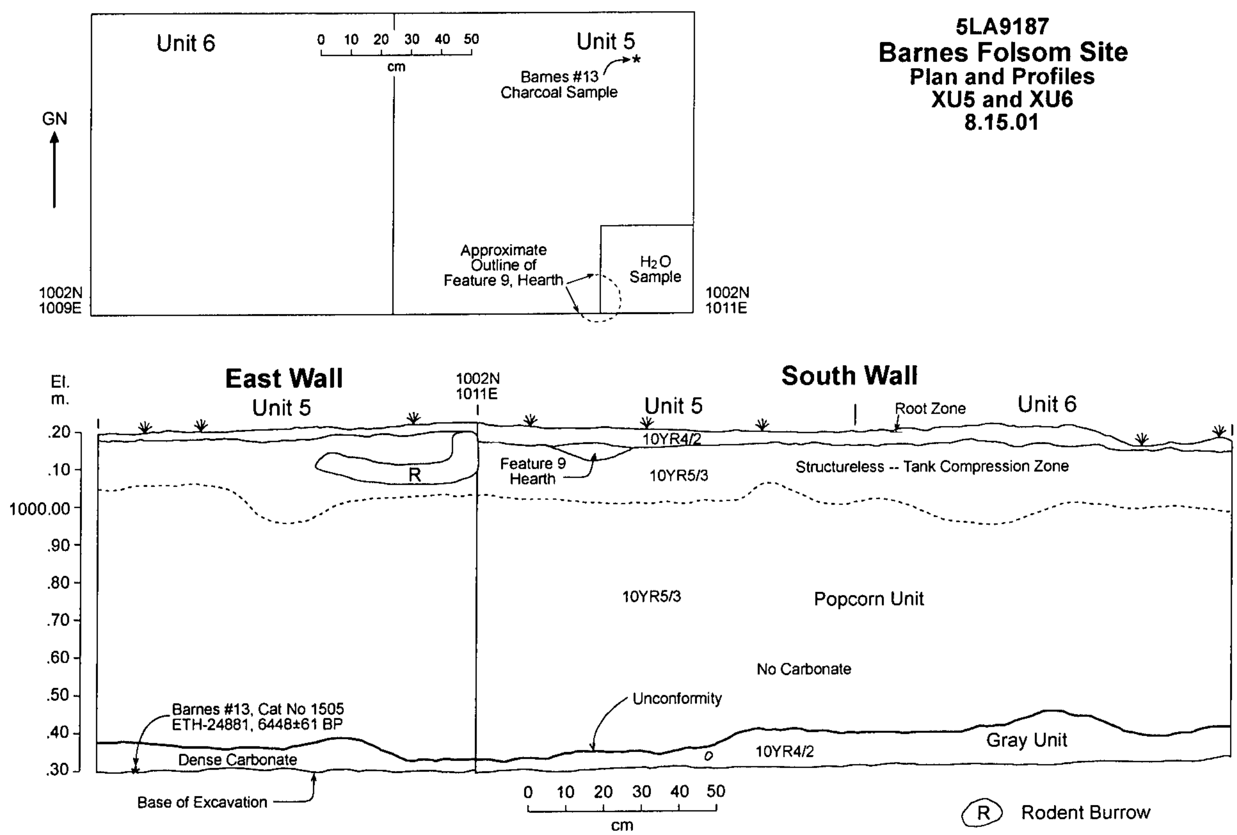


Figure 23. Profile and plan drawings for excavation Units 5 and 6 at the Barnes site, 5LA9187.

surface of the gray unit was encountered in the lowermost 15-20 cm of excavation. By the time excavation reached and entered the gray unit, we had no strong interest in digging deeper, understanding by that time that the gray unit was a truncated B horizon rather than an A horizon, and therefore much less likely to contain artifacts. The upper three levels of these two units were

removed with complete recovery, levels 4-7 were subjected to waterscreened recovery only (with the 8/9ths dryscreen portion of each level removed without screening), and full recovery was resumed as excavation approached and entered the gray unit in the lowermost two excavation levels (Table 12, Figure 23). Plotted charcoal from near the floor of the unit (Cat. No. 1505, Barnes # 13) was radiocarbon dated at 6448 ± 61 BP (ETH-24881; Table 5, Chapter 4); this date is associated with the gray unit at this location (see discussion by D. Kuehn in Chapter 4).

Table 12. Quantitative data for artifacts and materials by level in excavation Units 5 and 6 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 5								Unit 6										
LEVEL	Flakes G1-4	Stone Tools	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Sherds G1-3	FCR	Unburned Bone G1-5	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)
1 (F9)	26	2	4	1		230	309	1	11	12	2	1	2			126	360	
2	1				1	21	22	2								24	20	
3					1	8	14	3	1				1			3	9	
4						*8*		*4*								*15*		
5						*8*		*5*								*9*		
6					*1*	*3*		*6*								*20*		
7								*7*							*1*	*1*	*2*	
8					1	12	35	8								175	77	173
9				2	3	407	315	9						2		107	114	
Tot	27	2	4	3	7	697	695	Tot	12	12	2	1	3	2	1	480	582	173

No artifacts were recovered from deep contexts (below level 3) in Units 5 and 6. Charcoal and snails are documented in the excavation inventory, although snails were not systematically sorted from G4 and G5 fractions from these two units.

A small remnant of a hearth, Feature 9, was documented at the base of the thin root mat at a depth of about 5-6 cm below the current surface. The hearth was probably once larger and is now mostly eroded away. The hearth was represented by a 15-cm diameter lens-shaped area of charcoal-stained sediment that was noted in the waterscreen excavation block and that extended slightly into the south wall of Unit 5 (Figure 23). Feature 9 is almost certainly Late Prehistoric in age, as the first excavation level containing the hearth also produced pottery, flakes, stone tools, FCR, and small burned bone fragments typical of the Late Prehistoric component (Table 12).

Units 9 and 10

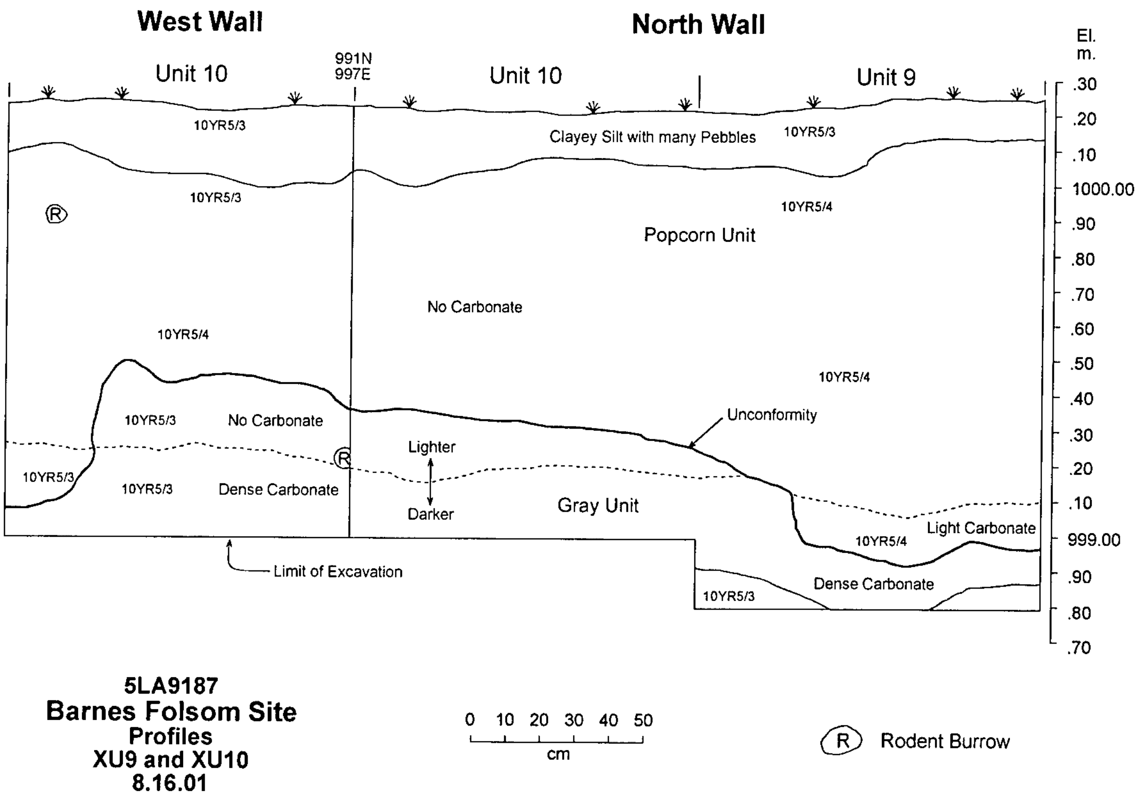
The Unit 9 and 10 excavation unit pair was placed about 18 meters southwest of Trench 1A and eight meters northeast of the upslope end of Trench 4A (Figure 20). This unit pair was placed in a spot where we thought Sediment Package 2 might exist, based on the lay of the land and existence of the faint terrace scarp that formed the T1 / T2 boundary about 5 m west of the

test location. Such proved to be the case, as excavations here penetrated the typical popcorn over gray unit sequence seen in SP2 in Trench 1A. Profile drawings for all four walls of these test pits are shown in Figure 25, and quantitative data for materials recovered in excavation occur in Table 13.

Figure 24. Photograph of the south wall of Unit 9 and part of Unit 10 showing the popcorn unit overlying the carbonate-rich gray unit at the base of the profile, 5LA9187.

Unit 9 was excavated in 15 arbitrary levels and Unit 10 in 13 levels. Excavation proceeded with full recovery in levels 1-3, with screening of the waterscreened sample fraction only for levels 4-9, and with full screened recovery for the remaining excavation levels. Excavation revealed an extremely complex, unconformable contact between the popcorn unit and the underlying gray unit. The unconformity marking this contact was quite distinct, accentuated in part by absence and presence of abundant carbonate nodules. Figure 24 illustrates the character of the popcorn unit, with abundant blocky, subangular ped structure, and the carbonate-rich (speckled, darker) gray unit in the lower part of the section. In places, such as the west wall of Unit 10 (Figure 25), the unconformity was nearly vertical and exhibited about 40 cm of relief over a horizontal distance of only 20 cm. When this contact was first encountered and only partially exposed, horizontally, in excavation, the boundary was so abrupt and near-vertical in orientation that it was thought to be a cultural intrusion. It was designated in the field as cultural Feature 11, but later was demonstrated through continuing exposure to be a geologic phenomenon. Careful inspection of all four profiles after excavation (Figure 25) revealed several small, mixed or mottled sediment bodies that undoubtedly represented eroded gray unit material splayed out onto a highly irregular ground surface (or local channel surface) during the brief period when processes shifted from erosional to depositional in nature.

The excavation inventory (Table 13) indicates an absence of artifacts below level 2 in excavation. A single piece of unburned bone was recovered from level 10 of Unit 10; this bone is a size G5 fragment of a phalange of a very small mammal, perhaps the size of a ground squirrel. Several rodent burrows are documented in the Unit 9 and 10 profiles (Figure 25), and this is probably a relatively recent intrusive item within sediments that are mid-Holocene in age (see discussion of chronology in Chapter 4). Snails and occasional pieces of charcoal are



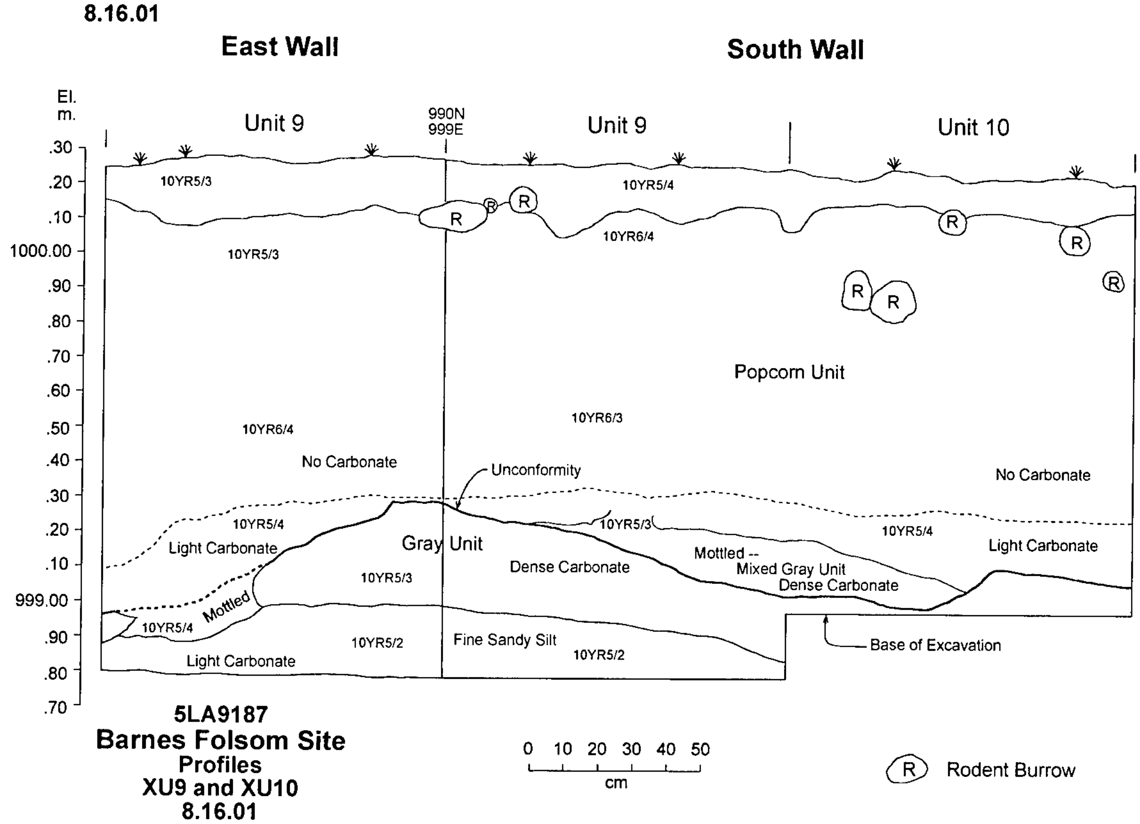


Figure 25. Profile drawings for excavation Units 9 and 10 at the Barnes site, 5LA9187.

Table 13. Quantitative data for artifacts and materials by level in excavation Units 9 and 10 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 9									Unit 10										
LEVEL	Flakes G1-4	Sherds G1-3	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	Unburn Bone G1-5	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)
1	25	3	1			730	1494		1	11	1	2		4			354	843	
2	10	4	1			597	1477		2	2	1	3		2			405	1199	
3						112	115		3								162	521	
4						*28*	*3*		*4*						*1*		*91*	*60*	
5				*3*		*67*	*9*		*5*								*45*	*14*	
6						*44*	*17*		*6*								*63*	*13*	
7					*1*	*129*	*85*		*7*							*1*	*21*	*4*	
8						*54*	*18*		*8*								*<1*		
9						*8*			*9*								*<1*		
10	**(F11)**					10	1		10	**(F11)**			1				5	26	
11						96	5	29	11	**(F11)**							221	14	1
12				1		86	6	139	12	**(F11)**					1		962	40	105
13					1	149	94		13						2	1	916	58	83
14				2		676	317	247											
15						259	280	201											
Tot	35	7	2	6	2	3045	3921	616	Tot	13	2	5	1	6	4	2	3245	2792	189

documented at various depths in the excavation, although snails were not systematically sorted from G4 and G5 waterscreen fractions. Snails are actually much more abundant than reflected in Table 13. Pedogenic carbonates were sorted from some of the waterscreen samples in this unit, and the partial data set indicates a concentration of such material in the gray unit deeper than level 11 in excavation (Table 13). The Late Prehistoric cultural component at this location is confined to the two uppermost excavation levels and consists of several flakes, small numbers of sherds and small pieces of burned bone, and a single stone tool.

Units 36 and 37

This excavation unit pair was placed about two meters from the wall of Trench 3A at a location where the trench exposure indicated that the Sediment Package 2 sequence would occur (Figure 20). Our purpose in excavation at this location was spatial sampling of the Late Prehistoric component and yet another exposure of the upper surface of the gray unit. Excavation unit profiles are shown in Figures 26 and 27, and quantitative data regarding materials recovered in excavation are provided in Table 14.

Excavation occurred in eight arbitrary levels in Unit 36, which were sufficient to slightly penetrate to the top of the gray unit and demonstrate an absence of artifacts at this unconformable contact, and in seven arbitrary levels in Unit 37. Excavation exposed a discontinuous root zone or A horizon, a fairly typical expression of the popcorn unit, and an

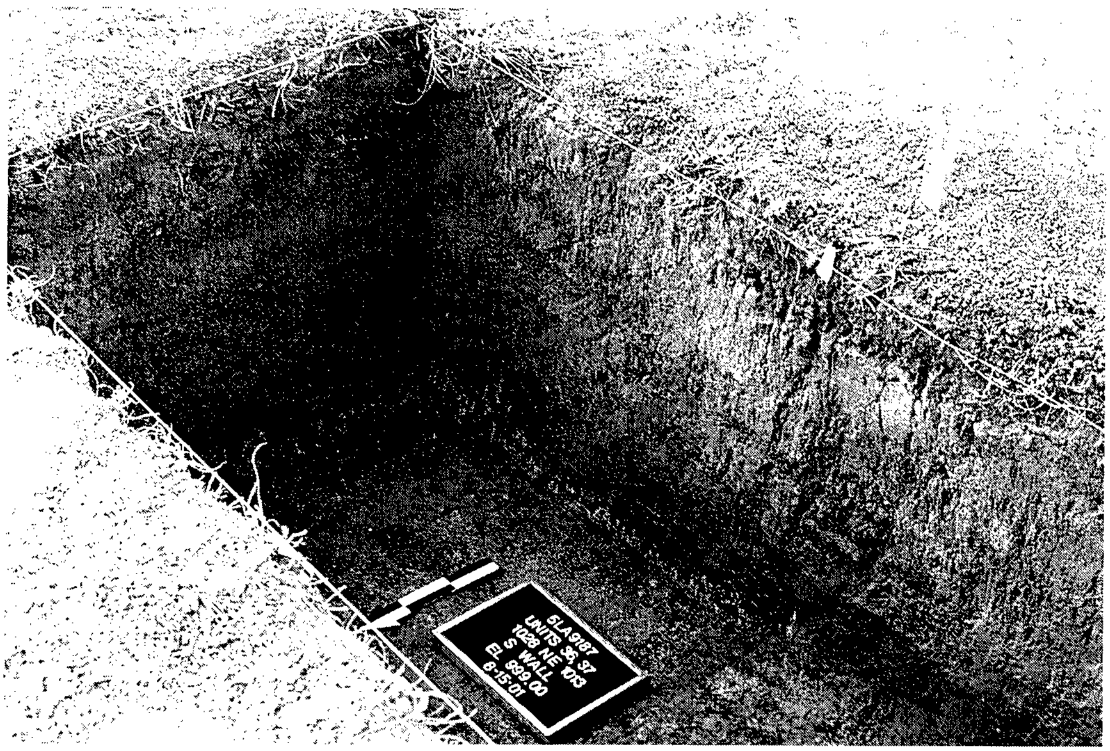


Figure 26. Popcorn unit (most of the profile exposure) and gray unit with carbonate exposed in Units 36 and 37 at the Barnes site, 5LA9187.

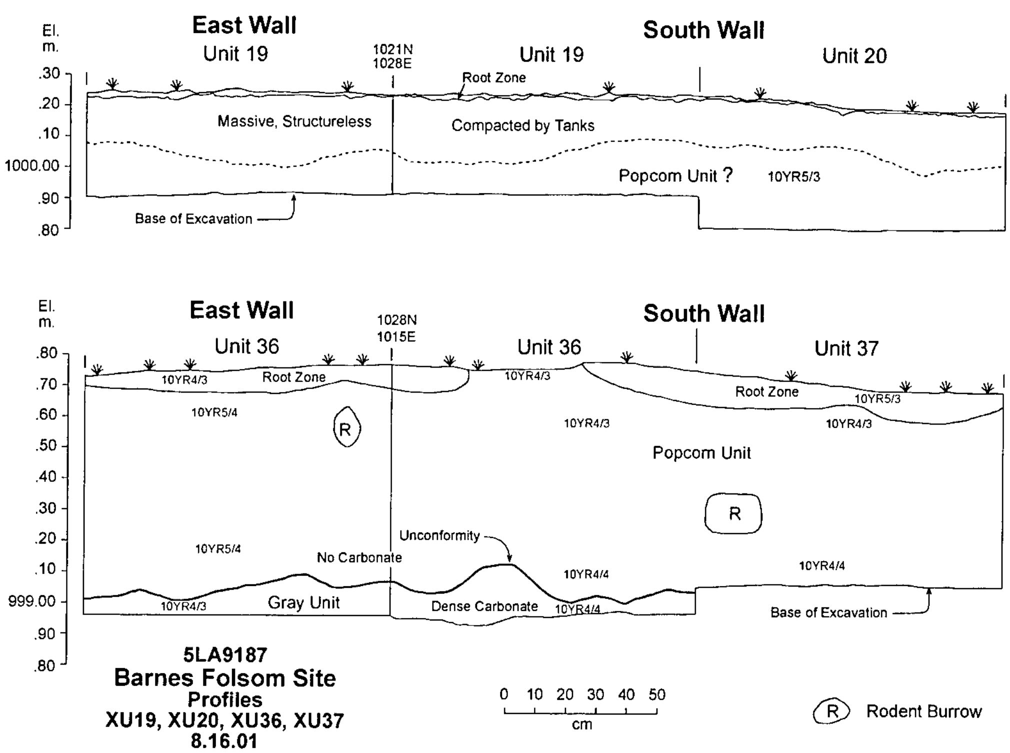


Figure 27. Profile drawings for excavation Units 36 and 37 at the Barnes site, 5LA9187.

Table 14. Quantitative data for artifacts and materials by level in excavation Units 36 and 37 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 36							Unit 37					
LEVEL	Flakes G1-4	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)	LEVEL	Burn Bone G1-5	Snails P/A	Residue (g)	Natural Rock (g)	Pedog. Carb (g)
1	1			49	53		1	1		48	39	
2				12	26		2			41	41	
3				20	21		3			25	15	
4		1		6			4			61	30	
5				8	1		5			18	10	
6		2		55	78		6			52	84	
7		3		75	32	13	7		3	53	52	4
8			1	45	21	45						
Tot	1	6	1	270	232	58	Tot	1	3	298	271	4

abrupt, undulating contact with the gray unit that was heavily charged with nodular pedogenic carbonate (Figures 26 and 27). A modest amount of rodent disturbance was documented in unit profiles, within the popcorn unit. No artifacts were recovered in deep contexts (Table 14). The Late Prehistoric component was very sparsely represented on the ground surface at this location, and excavation data in Table 14 document that this component is equally sparse below ground at this location. Recovered artifacts consist of a single flake and a single small fragment of burned bone.

Excavations Near the Folsom Find

One excavation unit pair (Units 7 and 8) was placed very near the original Folsom artifact surface find, and two unit pairs were placed in nearby locations to provide greater spatial coverage of the area immediately around the find (see Figure 20). Only one of these pairs was excavated deep enough to expose and sample Sediment Package 3 in this part of the site.

Units 7 and 8

This unit pair was placed immediately next to the original Folsom surface find and about seven meters from the nearest face of backhoe Trench 1A (Figure 20). When originally laid out, it was unclear if this excavation would penetrate the SP2 sequence (popcorn over the gray unit) or the SP3 sequence (structureless alluvial deposits dominated by fine sands) as exposed in Trench 1A. The majority of the excavation penetrated deposits conforming to the SP3 description, but with a yet different sediment body exposed in one corner of the test pit. Excavation profiles are shown in Figure 28, and quantitative data for recovered artifacts and other materials are provided in Table 15.

Excavation occurred in 11 arbitrary levels and through a depth of slightly over one meter in each excavation unit. As excavation continued during the last four or five levels, one of the excavators (Cherie Freeman) noted a distinctly different sediment unit in the extreme southeast

corner of Unit 7, where the waterscreen sample for that unit was taken. It was not until excavation was completed and the profiles cleaned and inspected in detail that the geological complexity in the square was fully apparent. Four distinct stratigraphic units, having at least two distinct ages, were exposed in the two units.

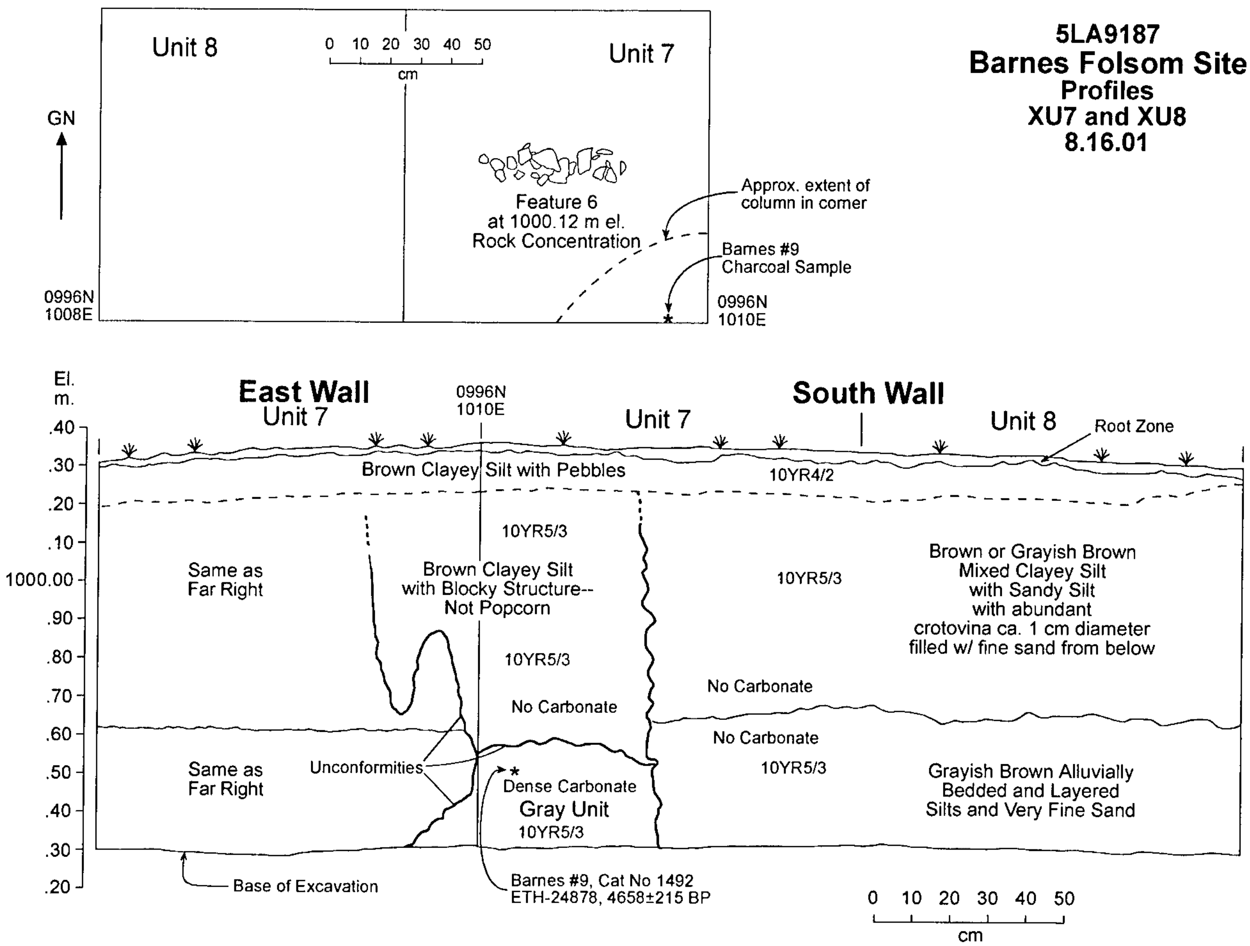


Figure 28. Profiles for excavation Units 7 and 8 at the Barnes site, 5LA9187.

The lowermost one-third of the majority of both Unit 7 and Unit 8 was comprised of alluvially bedded, layered silts and very fine sands. This was overlain by a massive body of predominantly clayey silt that continued vertically to near the present surface and that was honeycombed with crotovina about 1 cm in diameter that were filled with the very fine sand and silt from the underling alluvial deposit (Figure 28). Both of these layers lacked any apparent soil structure as well as visible carbonates.

In the extreme southeastern corner of Unit 7 a second, separate, two-layered package of older sediment occurred. It stood as an island or column of older sediment surrounded by the materials just described. This column was dense and compact, predominantly clayey silt, and its contact with the surrounding materials having a substantial sand component was either vertical or overhanging (Figure 28). The upper two-thirds of this column in the corner exhibited

substantial blocky soil structure, but with a ped size much larger than and distinct from the "popcorn" unit noted in several of the backhoe trenches. This layer with structure unconformably overlay what appeared to be the gray unit, or at least a layer with dense, visible carbonate much like that in the gray unit. The position of the upper part of this corner column on the landscape – upslope from the popcorn unit in Trench 1A – indicated that it must predate the popcorn unit in age. And this whole column predates the majority of the sediment in this test pit containing abundant fine sand. From oldest to youngest, the sediment sequence in this test pit was: the gray unit, the brown clayey silt with blocky structure, the alluvial silt and very fine sand, and the honeycombed clayey/sandy silt layer. Each was separated from one another by what appeared to be erosional unconformities. A plotted piece of wood charcoal in the upper part of the oldest, carbonate-rich gray (?) unit was radiocarbon dated at 4658 ± 215 BP (ETH-24878; Table 5, Chapter 4). All other sediment bodies in this test pit are younger in age.

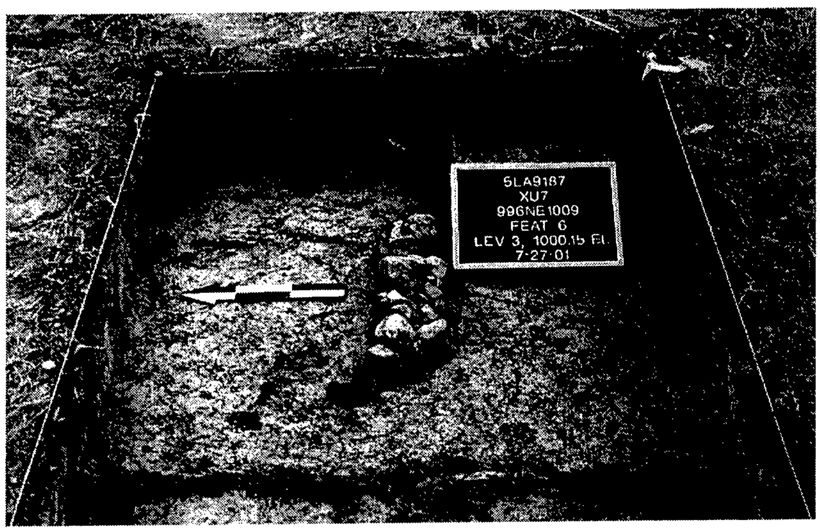


Figure 29. Feature 6, a linear array of cobbles, as exposed in level 3 in excavation unit 7 at the Barnes site, 5LA9187.

A single feature was recorded in this excavation unit pair, this being a linear arrangement of cobbles that occurred within the third excavation level. The array of cobbles, designated Feature 6, was about 15 cm wide and 50 cm long, as shown in the drawing in Figure 28 and the photograph in Figure 29. Fourteen cobbles were mapped in the array, and the collected sample weighed about 1.16 kg. The group of cobbles, about 7 cm thick vertically, was "suspended" within the otherwise fine-grained, silty sandy massive sediment body that covered most of Unit 7. None of the cobbles appeared to have been burned, geologically recently fractured, or modified in any way. No cultural explanation for the cobble array can be offered, and it is assumed that this feature was probably natural in origin.

The artifact and material inventory (Table 15) lists two sherds and some flakes from deep contexts. Two size G3 body sherds occur in level 4 in Unit 7. One is eroded, of indeterminate thickness, and has a plain interior or exterior surface. The second is 4.7 mm thick and bears a hint of smoothed-over cord-roughened exterior surface treatment. Each has coarse alluvial sand temper, made up mostly of quartz, with temper particles making up perhaps 40-50% of the volume of the paste. Based on the slight apparent difference in density of temper, these sherds might derive from a vessel different from that for sherds found in deep contexts in Units 1 and 2 (see above). Regardless, these two body sherds likely derive from the Late Prehistoric component at the site and probably found their way into level 4 through intrusive mechanisms.

Table 15. Quantitative data for artifacts and materials by level in excavation Units 7 and 8 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 7								Unit 8								
LEVEL	Flakes G1-4	Stone Tools	Sherds G1-3	Burn Bone G1-5	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Stone Tools	Sherds G1-3	FCR	Burn Bone G1-5	Charcoal P/A	Residue (g)	Natural Rock (g)
1	15		33	4	1	258	864	1	18		14	1			237	463
2	28	2	20	2		315	805	2	13	2	27		2		392	1049
3 (F6)			3			144	1374	3	19		2				74	195
4			2			39	52	4						1	18	24
5						32	13	5							14	2
6						7	3	6							7	
7						9	2	7	9						26	
8	2					10	19	8							16	
9						13	6	9							61	6
10					1	30	17	10							31	6
11						14	16	11							27	5
Tot	45	2	58	6	2	871	3171	Tot	59	2	43	1	2	1	903	1750

The inventory (Table 15) includes two items tabulated as flakes from level 8 of Unit 7. One of these is a large, size G1 spall broken from a much larger piece of parent material. The spall measures 9 x 4 cm and was detached from the larger rock through some type of stress fracture (heat or freeze-thaw) rather than by external force application. The stone appears to be Thatcher limestone and has sharp, geologically unworn edges. It was flat-lying in the alluvial silt / fine sand unit. Given its size, it is geologically out of place, but has no clear cultural features. The dryscreen sample in the same level produced a single G3, non-cortical complex flake of brown orthoquartzite. The same kind of raw material is common in the surface collection, and the age of this flake (intrusive Late Prehistoric, or in situ Archaic) cannot be determined with certainty. In addition to these two specimens, a single size G4 flake was recovered in the waterscreen sample of level 7 in Unit 8 (= estimated count of 9 flakes in Table 15). This is a non-cortical trimming or pressure flake made of a fine-gained, off-white chert-like material resembling Flattop chalcedony. It is unclear if this specimen was in context or was intrusive through some type of disturbance process. The latter is possible given the small size of the specimen and high density of small crotovinas in the sediment unit only 5-15 cm above the elevation of this specimen.

In sum, the evidence suggests but does not demonstrate with certainty the presence of sparse cultural materials in the alluvial silt / fine sand sediment unit that comprises the majority of these two excavation units. The Late Prehistoric cultural component is well represented in this excavation (Table 15). Flakes and sherds are abundant in the first two excavation levels, along with a few pieces of burned bone, four stone tools, and one piece of FCR.

Units 24 and 25

This excavation unit pair was opened at a spot one meter grid south of Units 7 and 8, just discussed. These units were designed to collect a larger sample of near-surface artifacts in this location, in close proximity to the Folsom find spot. Because the Folsom point has been determined to have been geologically transported, and not in context, Units 24 and 25 now serve the main purpose of providing a larger sample of the Later Prehistoric component that is well-represented on the surface in this area. Figure 30 provides profile drawings for these two units, and data for recovered artifacts and other materials are provided in Table 16.

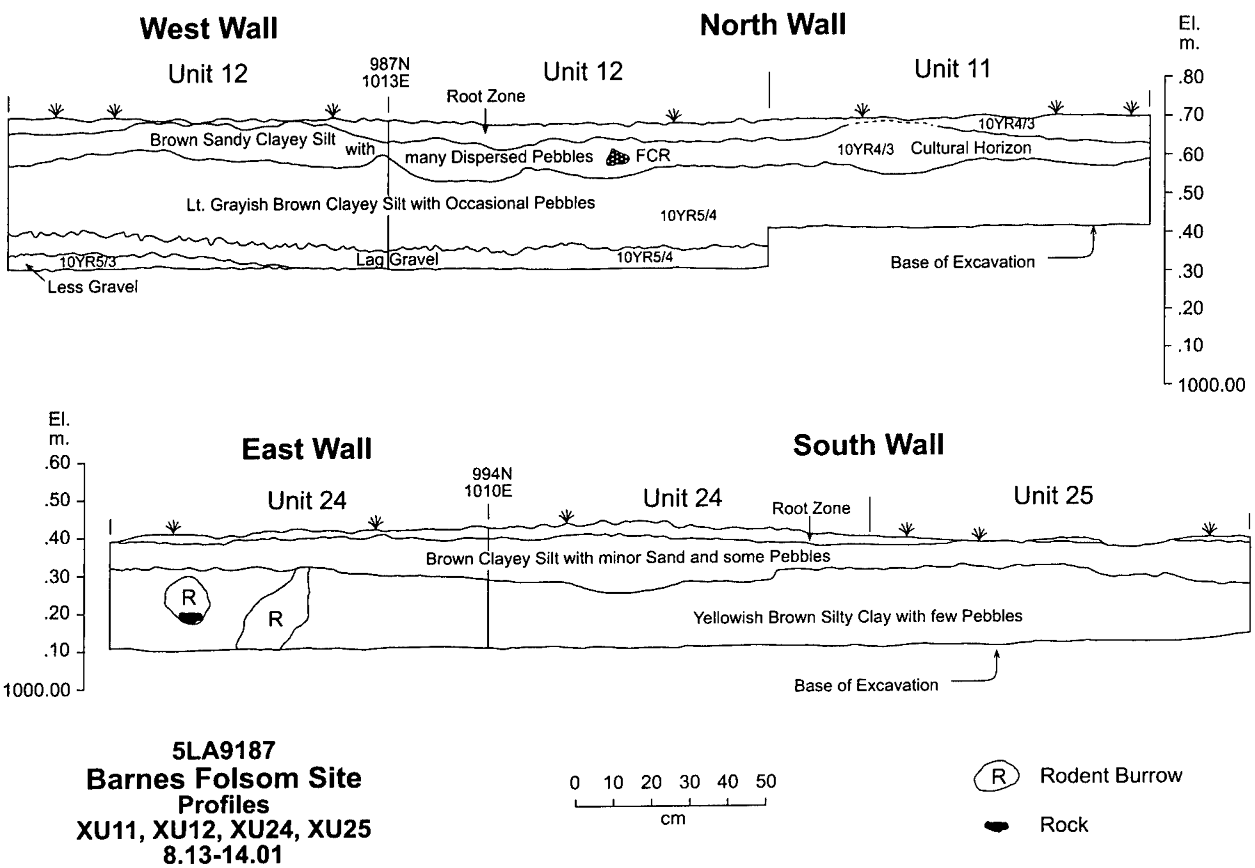


Figure 30. Profile drawings for excavation unit pairs 11 and 12, and 24 and 25, at the Barnes site, 5LA9187.

Three arbitrary excavation levels were removed from Units 24 and 25. Excavation penetrated a discontinuous, thin root mat and a 10-12 cm-thick A soil horizon, overlying yellowish brown clayey silt. Excavation plans and profiles reveal a modest amount of near surface rodent disturbance at this location. Artifact data indicate a fairly dense Late Prehistoric age deposit, concentrated in the uppermost excavation level. The makeup of the artifacts is very similar to that in nearby Units 7 and 8, with roughly equal numbers of sherds and flakes, and much smaller frequencies of burned bone, stone tools, and FCR. No cultural features were noted in these two excavation units.

Table 16. Quantitative data for artifacts and materials by level in excavation Units 24 and 25 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 24									Unit 25								
LEVEL	Flakes G1-4	Tools	Sherds G1-3	FCR	Burn Bone G1-5	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	FCR	Burn Bone G1-5	Charcoal P/A	Residue (g)	Natural Rock (g)
1	49	1	25		4		490	1622	1	28	1	30	1	1	1	515	1257
2	13		8		1	1	190	739	2			5				227	1026
3				1			23	1517	3			1				24	42
Tot	62	1	33	1	5	1	703	3878	Tot	28	1	36	1	1	1	766	2325

Units 26 and 27

This excavation unit pair was placed two meters grid east of Units 24 and 25, just described (see Figure 20). These excavations were well within the zone encompassing the high energy alluvial Sediment Package 3, and they were not expected to reach depth. Their purpose was the same as for Units 24 and 25 – expanding the sample from near the Folsom surface find, and particularly, areal coverage in the Late Prehistoric age component at the site. Plan and profile drawings for Units 26 and 27 are shown in Figure 31, and quantitative data regarding recovered artifacts and other materials are presented in Table 17.

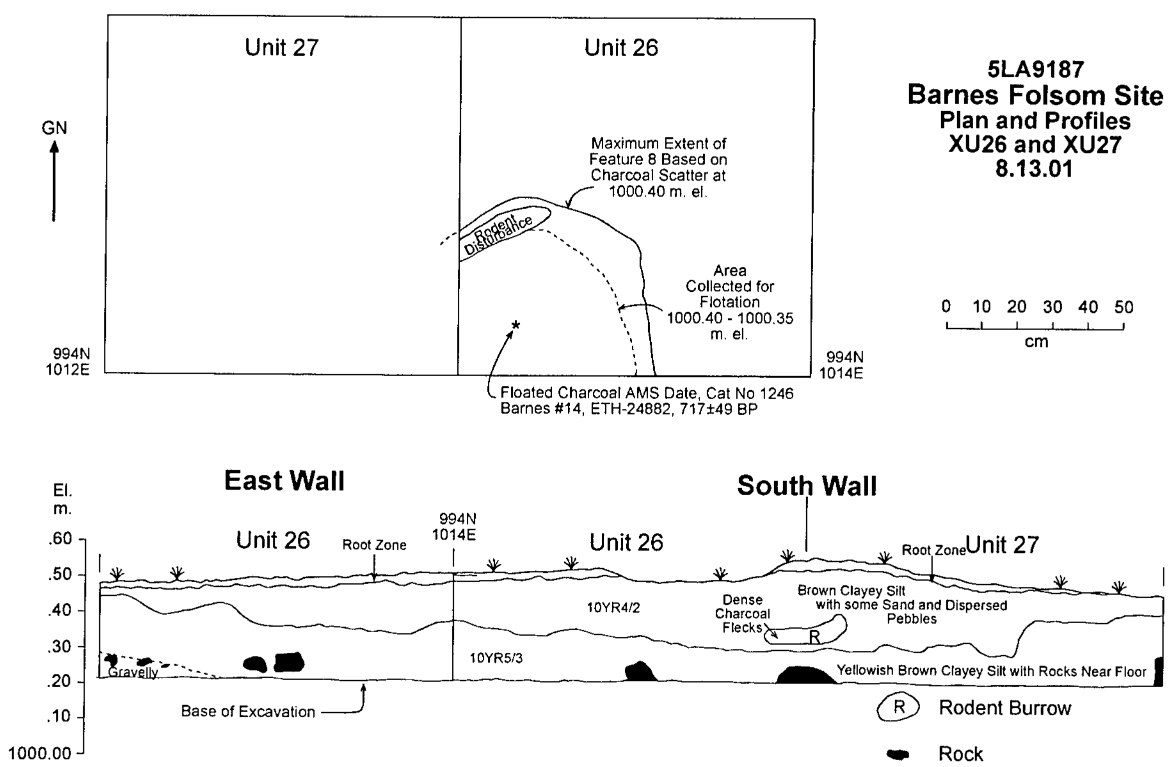


Figure 31. Profile and plan drawings for excavation Units 26 and 27 at the Barnes site, 5LA9187.

Excavation occurred in three arbitrary levels in each of the units, reaching a depth of approximately 30 cm below local surface. Excavation penetrated a thin and discontinuous root mat, a 15-18 cm thick brown horizon containing artifacts, and a lighter clayey silt unit that produced increasing amounts of natural rock and gravel near the base of the third level (Figures 31 and 32).

Figure 32. Floor and south wall of excavation Unit 26 and part of Unit 27 showing rocks and gravel in floor of unit and rodent burrow (above the rock) filled with charcoal-rich sediment from hearth Feature 8, Barnes site, 5LA9187.

A single cultural feature, a sizeable hearth designated Feature 8, was encountered in excavation. This hearth lay primarily in Unit 26 and extended into the south wall of that square. It was identifiable as a roughly circular area containing smears and small concentrations of charcoal. The feature was identified at the base of the first excavation level in Unit 26, and the majority of the sediment in the hearth area was collected in bulk and was processed by flotation in the lab. Upon close inspection, it was determined that the hearth itself probably was mostly deflated or eroded away, and that the concentrations of charcoal observed during excavation lay primarily in rodent burrows that had passed through the feature at some time in the past and had become filled with hearth matrix. Figure 32 shows the floor of Unit 26 at the base of the third excavation level; evident in the south wall of the unit is a rodent burrow filled with charcoal-rich sediment (see also Figure 31). Nearly all of the artifacts recovered in each of the excavation units occurred in the first excavation level (Table 17), this being another indication of the eroded and deflated nature of the cultural deposit at this location. Several pieces of charcoal were plotted within or near the hearth remnant. Several proved submarginal in size for purposes of dating, and a piece of wood charcoal collected from one of the two bulk float samples was AMS dated to 717 ± 49 BP (ETH-24882; Table 5, Chapter 4).

The Late Prehistoric component is well represented at this location (Table 17), with collected specimens including modest numbers of sherds and flakes, seven stone tools, two pieces of FCR, and an atypically large number of bone specimens. Unburned bone specimens consist of skeletal fragments and elements from rodent-sized animals (probably recent and intrusive), while the burned bone, in contrast, consists of G3, G4, and G5 fragments from medium to large mammals.

Table 17. Quantitative data for artifacts and materials by level in excavation Units 26 and 27 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 26										Unit 27										
LEVEL	Flakes G1-4	Tools	Sherds G1-3	Unburned Bone G1-5	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	FCR	Unburned Bone G1-5	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)
1 (F8)	97	4	23	21	28	2	6	2775	1580	1	64	3	35	2	4	6			441	1012
2	2		3					262	851	2	21		8		7	1	1		295	871
3								433	8251	3	1		1					1	70	246
Tot	99	4	26	21	28	2	6	3470	10682	Tot	86	3	44	2	11	7	1	1	806	2129

Dispersed Excavations Sampling the Late Prehistoric Component

Three excavation unit pairs were placed at widely dispersed locations to sample different parts of the Late Prehistoric component evident in the surface collection. Units 11/12 and 13/14 were placed several meters south of the Folsom find location, yet well within the main surface artifact scatter that seems to form the core of the site (Figure 20). In contrast, Units 19/20 were placed well to the north, near the upslope end of Trench 3A, and in an area where surface artifacts were not numerous. This unit pair was originally designed to not only sample the surface component but also penetrate geologic deposits that lacked the gray unit at depth. As the season progressed, focus in deep excavations shifted exclusively to locations where the gray unit was known to occur, and deep work was abandoned in Units 19/20.

Units 11 and 12

This excavation unit pair lay within the approximate center of the fairly dense artifact scatter than could be called the core of the site, based on surface evidence (Figure 20). Gravels were evident on the ground surface at this location, and we expected that this unit pair would expose the gravel-rich Sediment Package 4 and therefore would be terminated at shallow depth. Such proved to be the case. Excavation profile drawings are shown in Figure 30 (above), and quantitative data for recovered artifacts and materials are provided in Table 18.

Excavation in both units penetrated a thin and intermittent root mat, a brown near-surface horizon containing some artifacts (note the FCR piece in the north wall of Unit 12 in Figure 30), and then a dense, compact grayish brown clayey silt layer. After removal of the first level, excavation in this location was similar to digging through cured concrete. A dense lag gravel was encountered within the fourth arbitrary excavation level in Unit 12, and at that point the decision was made to terminate work in this unit pair without removal of level 4 in Unit 11.

No cultural features were encountered in excavation of these two units, and, contrary to expectations based on surface evidence, only a modest number of artifacts was recovered

through excavation and screening (Table 18). The collection consists of the usual array of chipped stone debris and tools, sherds, burned bone, and FCR.

Table 18. Quantitative data for artifacts and materials by level in excavation Units 11 and 12 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 11								Unit 12							
LEVEL	Flakes G1-4	Tools	Sherds G1-3	FCR G1-3	Burn Bone G1-5	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	Burn Bone G1-5	Snails P/A	Residue (g)	Natural Rock (g)
1	29	1	3	3	1	280	1478	1	4	2	5			9	1305
2	2	1	1	1	1	642	813	2	2		1	1		234	900
3	3					86	417	3						95	835
								4					1	289	4924
Tot	34	2	4	4	2	1008	2708	Tot	6	2	6	1	1	627	7964

Units 13 and 14

This excavation unit pair lies the farthest south among all the units placed in the site (Figure 20), and it is within the southern part of the site core where surface artifacts were relatively abundant. Based on gravel on the surface, we did not expect this excavation to go deep. The excavation plan and profile drawings occur in Figure 33, and quantitative data for recovered artifacts and materials are presented in Table 19.

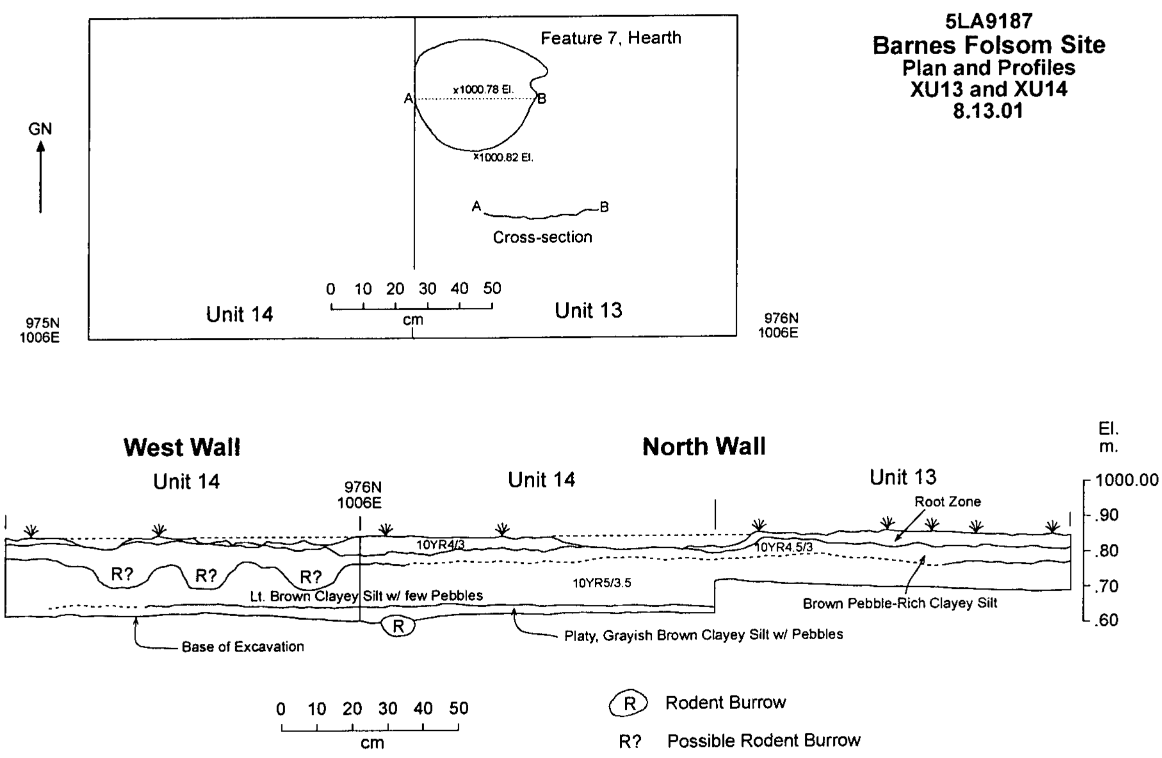


Figure 33. Profile and plan drawings for excavation Units 13 and 14 at the Barnes site, 5LA9187.

Table 19. Quantitative data for artifacts and materials by level in excavation Units 13 and 14 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 13									Unit 14							
LEVEL	Flakes G1-4	Tools	Sherds G1-3	Burn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Tools	Sherds G1-3	Unburned Bone G1-5	Burn Bone G1-5	Residue (g)	Natural Rock (g)
1 (F7)	8	3	3	12	1	1	724	1290	1	20	1	1		14	407	1582
2	3						228	526	2	1				1	271	885
									3			1	1		206	282
Tot	11	3	3	12	1	1	952	1816	Tot	21	1	2	1	15	884	2749

Excavation penetrated three arbitrary levels in Unit 14 and two in Unit 13. The profiles revealed a fairly predictable thin, intermittent root mat, a thin brown A horizon, and compact lighter sediment slightly deeper (Figure 33). The floor of Unit 14 slightly penetrated a platy, clay-rich layer containing pebbles. The base of a well-defined hearth designated Feature 7 was exposed at a shallow depth of about 5 cm below the local surface. Feature 7 was a dark, roughly circular stain (Figure 34) that contained dispersed charcoal and other burned material. Dark sediment filled a shallow basin about 4 cm deep (Figure 33). Feature 7 was the most regular and best-defined hearth associated with the Late Prehistoric component, yet, even so, it was probably partially eroded away at the site surface. Despite the presence of the hearth feature, the artifact content in these two units (Table 19) was not as high as is several excavations 20-25 m to the north (compare Tables 16 and 17). Flakes and burned bone fragments were most abundant, and small numbers of stone tools and sherds also occurred.

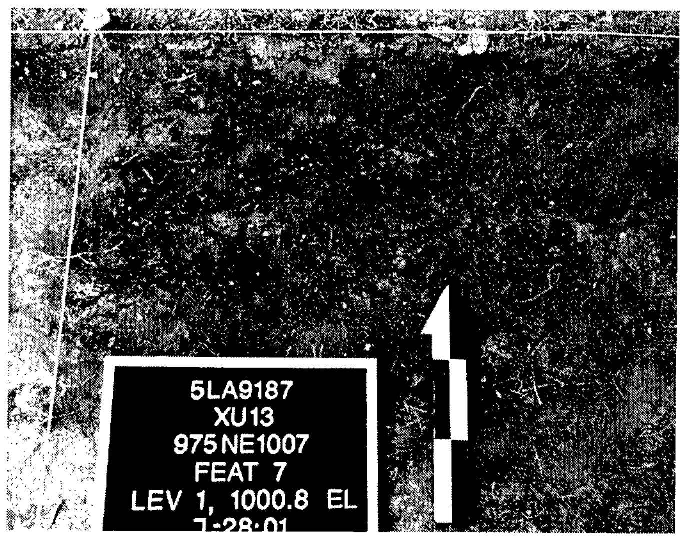


Figure 34. Hearth Feature 7 (dark stain directly above the photo board) exposed in the floor of Unit 13 at about 5 cm below surface at the Barnes site, 5LA9187.

Units 19 and 20

This excavation unit pair was placed well to the north next to the upslope end of Trench 3A, in an area where few artifacts occurred on the surface (Figure 20). As noted previously, we started this excavation with the intent of sampling deep deposits, but we abandoned this location when focus shifted to locations where the gray unit was thought to occur (the gray unit was absent in the Trench 3A wall at this location; see Chapter 4). Figure 27 (above) presents the

profile drawings for this unit pair, and quantitative data on recovered artifacts and materials occur in Table 20.

Unit 20 penetrated five arbitrary excavation levels, and Unit 19 only four. The profile drawings (Figure 27) indicate the blank nature of the stratigraphy at this location. The upper 25 cm of the deposit here was devoid of structure, apparently due to compression from heavy equipment. The lower half of the profile presented some soil structure, but lacked the abundant small blocky peds of the popcorn unit. A very small number of artifacts was recovered in excavation, these consisting of a few flakes, one stone tool, and two possible pieces of FCR. Unburned bone fragments are from elements of very small mammals, probably from recent intrusive burrowing rodents.

Table 20. Quantitative data for artifacts and materials by level in excavation Units 19 and 20 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 19								Unit 20						
LEVEL	Flakes G1-4	Tools	FCR	Unburn Bone G1-5	Snails P/A	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Unburn Bone G1-5	Snails P/A	Residue (g)	Natural Rock (g)
1	2	1				22	67	1				23	17
2	1		1			77	167	2	1	1		42	67
3			1	3	1	68	40	3		1		40	38
4					1	3	53	4			1		
								5			1	5	13
Tot	3	1	2	3	2	170	327	Tot	1	2	2	110	135

Excavations Near Trench 1C and Feature 10

A substantial concentration of charcoal that appeared to be a prehistoric hearth, designated Feature 10, was discovered by Jack Hofman early in the excavation program at a depth of about one meter in the southwest wall of Trench 1C. This was the single positive indication of buried prehistoric cultural activity at the site that predated the extensive, near-surface Late Prehistoric component. This feature, in addition to dispersed charcoal scattered throughout most of the exposures of the gray unit, would also provide a mechanism for developing the geochronology of the site. We therefore expended substantial effort toward exposing Feature 10 and recovering artifacts in direct association.

To access the buried hearth and an area around it, we needed to remove overburden with heavy equipment (see discussion in Chapter 2). The hearth occurred in a part of the site that produced only minor evidence of the Late Prehistoric component on the surface. We first dug one excavation unit pair (Units 28 and 29) to evaluate the density of cultural remains in near-surface deposits (Figure 20). We found few artifacts, and quickly made the decision to remove overburden and excavate a sizeable area around Feature 10. Overburden was taken out of a several square meter area to an elevation about 25-30 cm above the elevation of the hearth, then hand excavation was used to expose and remove the feature and excavate about a 5 m^2 area around the hearth in all or parts of six excavation squares (Units 30, 31, 34, 35, 38, and 39).

Unit 28 and 29

This excavation unit pair was located less than one meter from the southwest wall of Trench 1C (Figure 20). Two arbitrary levels were dug in each unit. Excavation penetrated a faint A horizon overlying uniform compact light brown clayey silt. Profiles of these shallow tests were not drawn, but Dave Kuehn (Chapter 4) describes in detail the stratigraphy exposed in the nearby northeast wall of Trench 1C. Quantitative data for recovered artifacts and other materials are provided in Table 21. Excavators did not record any artifacts while excavation was occurring, and sorting in the lab revealed only one flake and one piece of FCR. Based on the sparse occurrence of artifacts noted in the field, the decision was made to remove overburden in this vicinity and above Feature 10 without spatial expansion of this shallow, near-surface excavation.

Table 21. Quantitative data for artifacts and materials by level in excavation Units 28 and 29 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 28					Unit 29			
LEVEL	FCR	Burn Bone G1-5	Residue (g)	Natural Rock (g)	LEVEL	Flakes G1-4	Residue (g)	Natural Rock (g)
1	1	1	73	125	1	1	78	172
2			116	164	2		79	119
Total	1	1	189	289	Total	1	157	291

Units 30, 31, 34, 35, 38, 39 and Feature 10

As noted previously, the backhoe was used to remove overburden and create a nearly level area ca. 15-18 m^2 in area about 25-30 cm above the elevation of Feature 10 as it was exposed in the southwest wall of Trench 1C. Figure 14 in Chapter 2 shows hand excavation in progress at this location after removal of overburden. Figure 15 in Chapter 4 shows the stratigraphic position of Feature 10 projected onto the northeast wall of Trench 1C, and related discussion by Dave Kuehn in that chapter provides detailed data about stratigraphy.

Figure 35 shows the layout of the six excavation squares in the Feature 10 area and other spatial details of this operation. Quantitative data regarding recovered artifacts and other materials are provided by excavation level and unit in Tables 22-24. When these units were laid out (and Units 28 and 29, discussed above), their horizontal locations were established by taping from a line between the site datum (1000NE1000) and a secondary datum marker thought to lie due east of the primary datum. This secondary datum was later determined not to be on an even grid line, and the actual grid coordinates of all of these squares were reestablished by shooting from a total station set up at the primary site datum. Unit corner grid coordinates shown in Figure 35 are accurate according to the site grid, while nominal grid coordinates for the same unit numbers entered in the site catalog and level records are not accurate.

Units 30 and 31 were excavated first, in order to expose and remove Feature 10, the hearth. Excavation was later expanded in added pairs of units ,with Units 34 and 35 removed

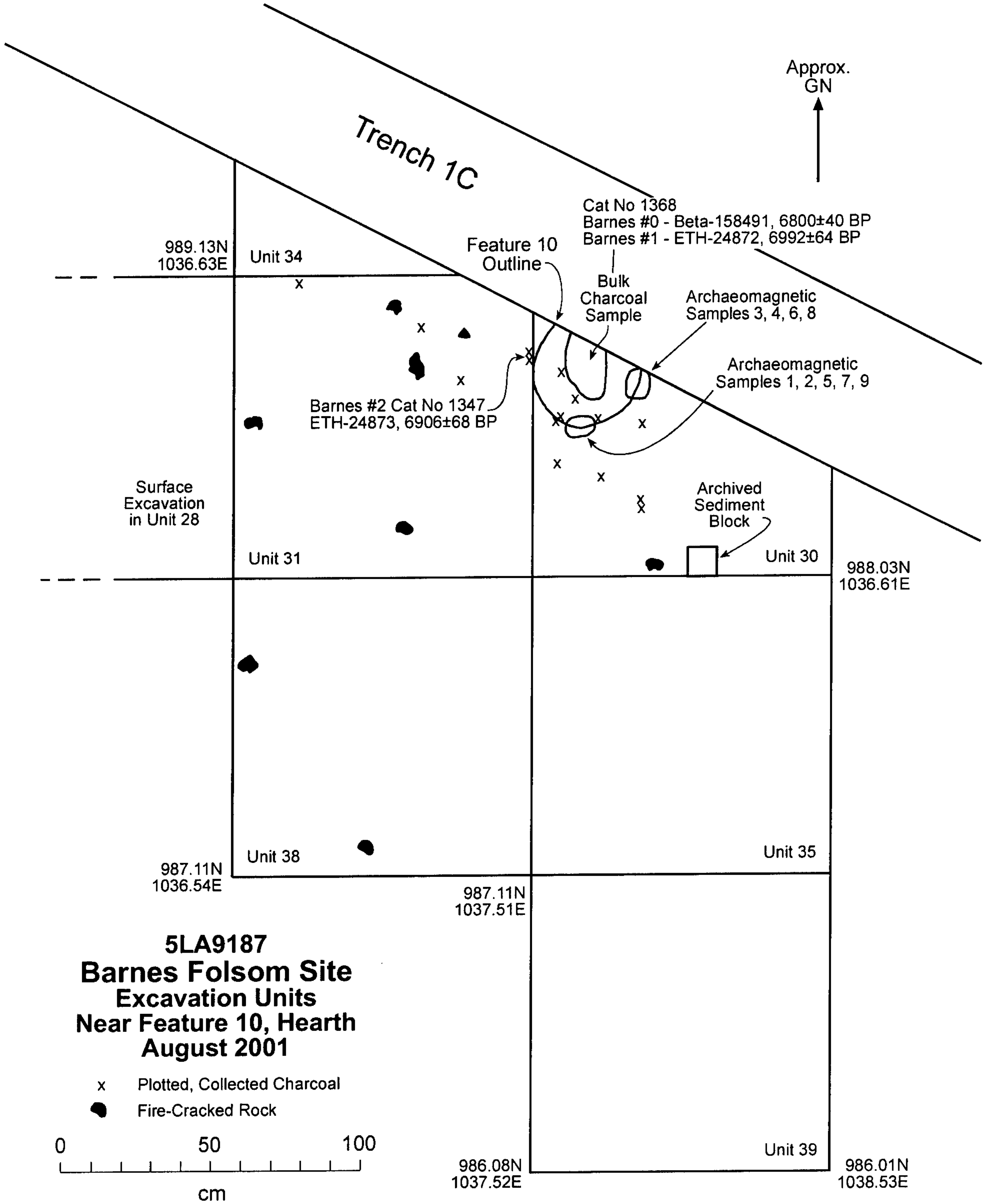


Figure 35. Plan of excavations over and near Feature 10, the deep hearth exposed in backhoe Trench 1C at the Barnes site, 5LA9187.

next, and Units 38 and 39 removed last. The beginning excavation surface (following removal of overburden) was slightly higher along the western side of the excavated area. Units 31, 34, and 38, along the western side of the small block, each started with excavation level 1. In order to keep the level numbering system synchronous among all squares (so that, for example, level 3 reflected the same elevation increment in all squares), no level 1 was removed from the eastern squares, and Units 30, 35, and 39 started with removal of what was labeled as level 2. Excavation in Unit 31 (level 1) began at an elevation of 1000.03 m, while excavation began in Unit 39 (level 2) at an elevation of 999.92 m.

Feature 10, as exposed in excavation (Figure 35), was roughly cut in half by backhoe Trench 1C. It was a shallow basin about 10 cm deep and 35 cm in diameter, filled with earth that was heavily charged with wood charcoal (Figure 36). A small bulk sample was taken from the most dense area of charcoal near the center of the hearth basin (Figure 35), and the balance of the sediment in the basin was removed as a bulk sediment sample and was floated in the lab for purposes of artifact recovery. Two small, slightly reddened burned earth areas occurred on the rim of the hearth basin at its eastern and southern margins (Figure 35), and Jeff Eighmy collected and analyzed several archaeomagnetic samples from these locations. Jeff reported a good paleomagnetic signature for these samples (his report occurs as Appendix C). A small, 10 x 10 x 10 cm block of sediment at the same elevation as the hearth and about 70 cm to its southeast (Figure 35) was also collected and archived for future study.

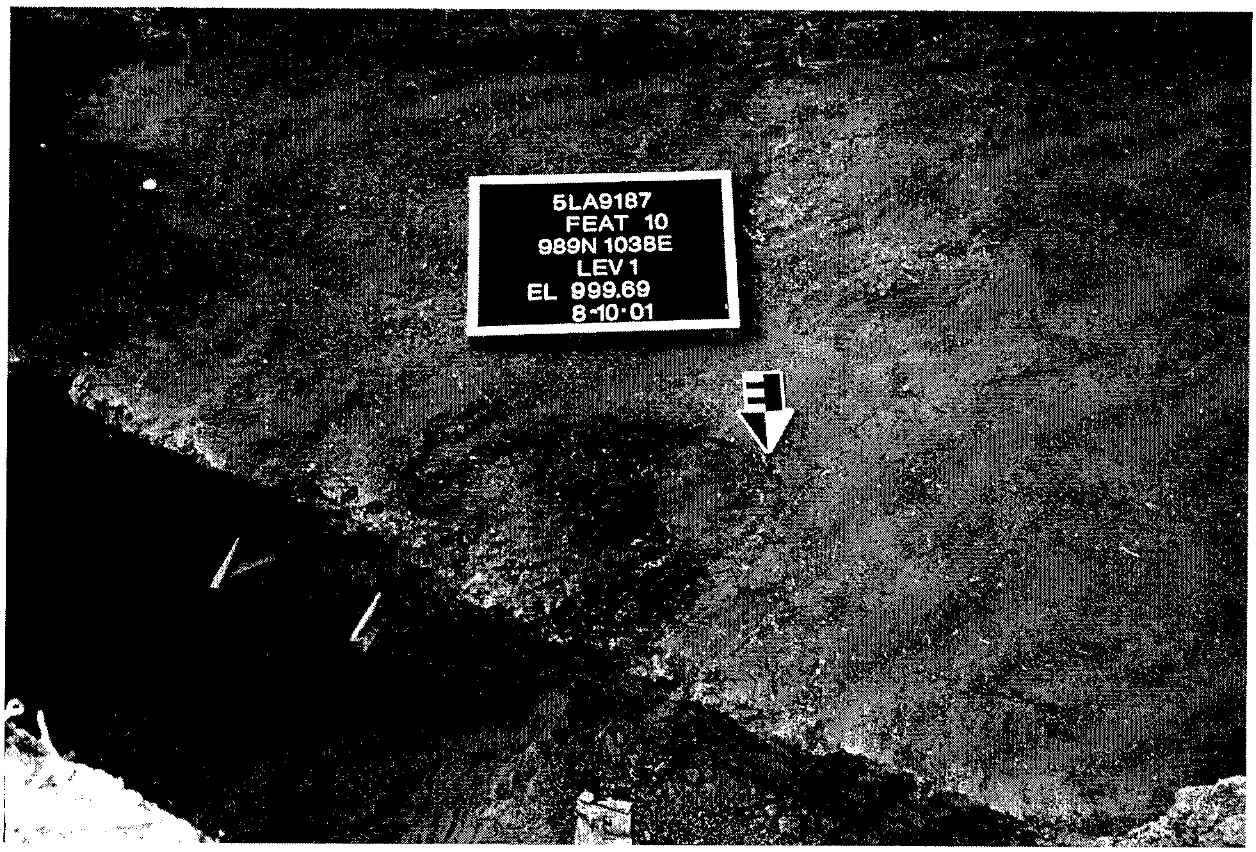


Figure 36. The deep hearth, Feature 10, exposed in Units 30 and 31 at an elevation of 999.69 m near Trench 1C at the Barnes site, 5LA9187.

Three AMS radiocarbon dates were produced on the hearth. Two pieces of charcoal picked at different times from the bulk charcoal sample taken from the center of the hearth (both are Cat No 1368) (Figure 35) produced dates of 6992 ± 64 BP (ETH-24872) and 6800 ± 40 BP (Beta-158491) (Table 5, Chapter 4). The disparate stable isotope ($\delta^{13}C$) values for these two dates indicate that they must be different species of wood. A third date of 6906 ± 68 BP (ETH-24873) was produced on a plotted piece of charcoal just outside Feature 10 and to the west in Unit 31. These three dates are internally consistent and indicate a radiocarbon age in the range of 6800-7000 BP for the hearth.

Snails were systematically sorted from the excavated samples and were abundant in sediments near Feature 10 (Tables 22-24). The artifact return can only be described as quite disappointing. Virtually nothing but charcoal (abundant) and fire-cracked rock (sparse) was recovered. Nearly every recovered pierce of FCR is plotted in Figure 35. The 12 specimens have a mean weight of less than 18 g and a total weight of 214 g, and probably represent the remains of but a single small stone cobble! A single, size G5 microflake, made of what appears to be red silicified wood, was sorted from waterscreen residue for level 1 in Unit 31. This location is at least 20 cm above the elevation of the hearth feature. Given its size, the association and context of this flake remain unclear, and its occurrence can be given little significance. The three specimens of unburned bone noted in Table 22 are very small, highly eroded pieces of very small mammal bone. They are probably intrusive rodent bones, unassociated with the hearth feature.

Table 22. Quantitative data for artifacts and materials by level in excavation Units 30 and 31 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 30							Unit 31						
LEVEL	FCR	Unburn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	FCR	Unburn Bone G1-5	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)
							1			2	2	6	10
2	4		1	3	7	14	2	3	1	3	3	18	15
3			1	6			3	3		1	3		
4 (F10)		1	5	10	59	11	4 (F10)			2	1	45	9
							5		1	2	1	9	
Tot	4	1	7	19	66	25	Tot	6	2	10	10	78	34

Table 23. Quantitative data for artifacts and materials by level in excavation Units 34 and 35 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 34		Unit 35				
LEVEL	Charcoal P/A	LEVEL	Snails P/A	Charcoal P/A	Residue (g)	Nat. Rk. (g)
1						
2	1	2	1	1	6	40
3		3	1	2		
4	1	4	1	2	6	3
Total	2	Total	3	5	12	43

Table 24. Quantitative data for artifacts and materials by level in excavation Units 38 and 39 at the Barnes site, 5LA9187. Flake counts include estimates of total G4 flakes per level.

Unit 38						Unit 39				
LEVEL	FCR	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)	LEVEL	Snails P/A	Charcoal P/A	Residue (g)	Natural Rock (g)
1					5					
2	2	1		12	40	2	1	1		4
3		1		4		3	2	1	5	
4		2	1	6		4	2	2	10	
Total	2	4	1	22	45	Total	5	4	15	4

Excavations In and Near Feature 5 at Trench 4A

Feature 5, a large pit, was first noted in the northeast wall of Trench 4A, and upon close inspection, a much larger portion of the pit was found to be intact in the opposite, southwest wall of the trench (Figure 20). The location and shape of the pit showed in the southwest wall of the trench only as a discontinuity in the popcorn structure in the sediment into which the pit intruded (the pit fill lacked popcorn structure) and as an area containing relatively large pieces of charcoal and one potsherd. To expose and excavate the pit, all or portions of four one-meter units (Units 21, 22, 23, and 40) arranged in a 2 x 2 m block were excavated over the feature. Three arbitrary levels were excavated from each unit with standard dry- and waterscreened artifact recovery. At the base of the third level, the outline of the pit was faintly visible, and the pit contents were removed in eight arbitrary levels that, with the exception of bulk sediment samples, were processed entirely by fine-mesh waterscreen recovery. Figure 37 shows the Feature 5 area after completion of excavation, and Figure 38 provides plan and profile drawings of the excavation area and the pit.

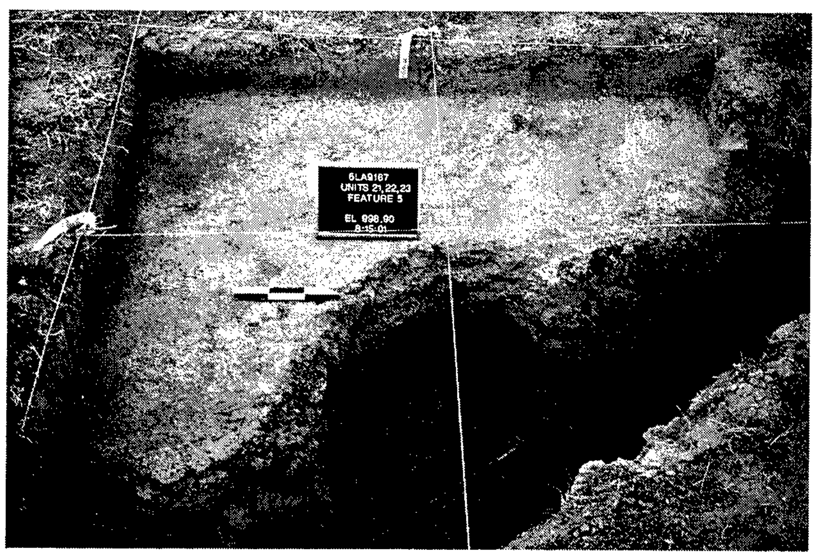


Figure 37. Late Prehistoric age pit Feature 5 and Units 21-23 and 40 after excavation at the Barnes site, 5LA9187.

Excavation of Feature 5 has been described in detail in a separate report by the excavator, Roche Lindsey (2001), and little additional detail will be provided here. Documentation indicates that the pit was roughly oval in shape, occurring in both sides of the backhoe Trench 4A (Figure 38). Pit dimensions are about 110 x 70 cm in plan by about 100 cm deep at the base, below surface. It is thought that the pit originated very near the present surface, due to its

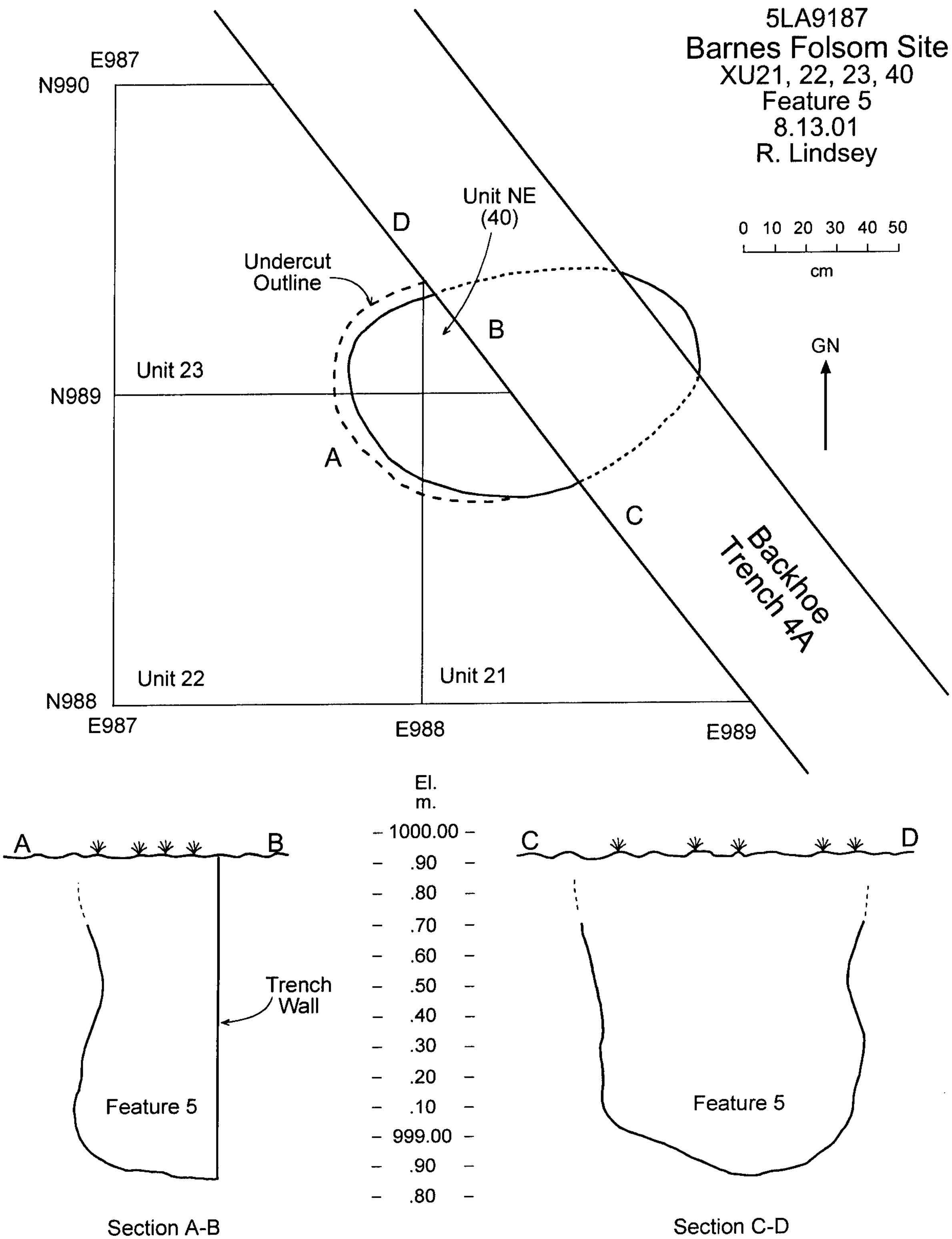


Figure 38. Plan and profile drawings of excavation Units 22, 23, 24, and 40 and of Feature 5 at the Barnes site, 5LA9187.

general artifact content that corresponds closely with the character of the extensive surface collection at the site. As noted in previous discussions, all artifacts and other materials recovered from the block excavation and the pit are being studied separately by Lindsey. By far the most remarkable discovery (Figure 39) within the pit was the existence of roughly 1500 white stone beads and smaller numbers of organic beads that occurred as several articulated short strings, loops, and strands. Individual stone beads were dispersed pretty much throughout the pit, but the articulated strands occurred primarily in four clusters in levels 7 and 8 very near the base of the pit.

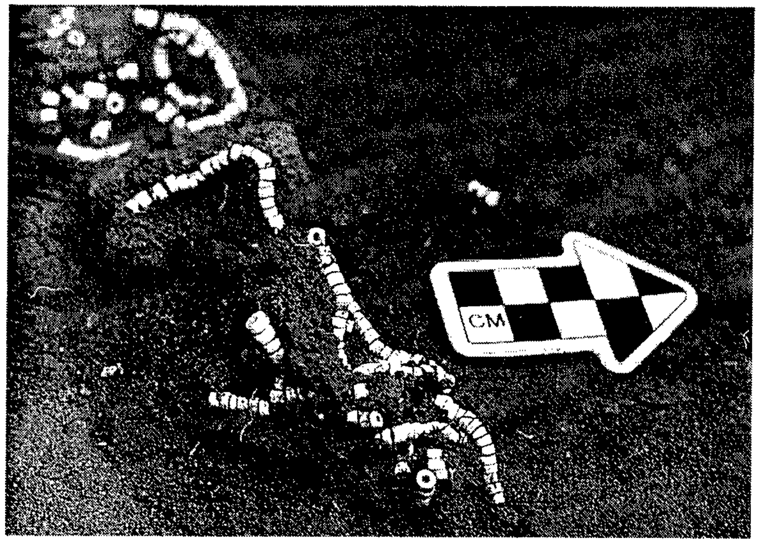


Figure 39. Stone beads in strands in Feature 5 at the Barnes site, 5LA9187.

Analysis related to Feature 5 that occurred in the PCRG lab consisted of selecting and submitting one plotted charcoal specimen for AMS radiocarbon dating, processing of one screened general level sample that was inadvertently included in the material returned to Flagstaff, and flotation processing of a bulk matrix sample collected from level 6 (50-60 cm) within the pit. The charcoal sample, from level 8 near the base of the pit, produced a date of 689 ± 49 BP (ETH-24879), which is consistent with another date reported from Feature 5 (see discussion in Chapter 4) and the date from hearth Feature 8 (see discussion above). Specimens sorted from the heavy fraction of the flotation sample include charcoal, snails, pottery, flaking debris, one small white stone bead similar to others in the pit, and one complete and several fragments of small organic beads (see discussion in Chapter 7).

Summary

Of the approximately 22.4 m^3 of fill processed by hand excavation at the Barnes site, about 40% or 9.0 m^3 came from the surface-most three excavation levels and about 60% or 13.4 m^3 from deep contexts. Several species of terrestrial snails occur in abundance in nearly all excavated contexts, providing a good potential source of paleoenvironmental information. Deep context excavations produced no evidence of Paleoindian archaeology (all excavated sediments being circa 7000 BP or younger in age) and extremely little evidence of Archaic age archaeology. The latter evidence is confined to a few problematic lithic items found in higher energy alluvial deposits in Units 7/8, and a single hearth (F10) with a few associated pieces of fire-cracked rock in the vicinity of Trench 1C. The hearth is well dated to 6800-7000 BP, but there are no interpretable cultural materials in association. One microflake was found near but stratigraphically above the hearth. Virtually all other artifacts found deeper than ca. 30 cm

below surface (fewer than a dozen specimens) are considered to have intruded downward from the Late Prehistoric age artifact scatter found near the surface of the site.

The surface-most three excavation levels produced a meaningful artifact collection consisting of (excluding artifacts found in and near Feature 5) 343 pot sherds, 280 pieces of flaking debris (with an estimated count of 936 specimens had the full excavated sample been processed over G4 screen), 115 pieces of burned bone (mostly very small unidentifiable fragments from what are thought to be medium to large mammals), 33 stone tools, 17 pieces of fire-cracked rock, eight fragments of burned earth, and two small fragments of possible red ochre. This excavation also exposed remnants of three hearth features and one pit feature. All of the hearths were partially if not severely eroded, and artifacts in the Late Prehistoric component are clearly concentrated in what appears to be a deflation lag very near the present ground surface. Of the enumerated artifacts, roughly 76% occurred in the first excavation level (within about 10 cm of the current surface), and 97% within the first two excavation levels (within about 20 cm of the current surface). The Late Prehistoric component is well-dated to circa 700 BP.

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7. CONCLUSIONS

Stanley A. Ahler

Geology and Geochronology

Studies of stratigraphy, soils, and radiocarbon-based chronology, discussed primarily in Chapter 4, demonstrate that the Barnes site contains an incredibly complex array of lithologic units and a geologic history marked by numerous cycles of erosion and deposition. Local surface topography suggests the presence of two depositional terraces, T1 and T2, yet the T2 landform contains stratigraphic and lithologic units too varied and spatially discontinuous to correlate beyond a single trench exposure in most cases. At many locations, a 1.5-m vertical exposure revealed the presence of four or more distinct soils, each separated by a vertical erosional or depositional unconformity. During excavations, we used the "gray unit" as a convenient and recognizable target for deep explorations in various parts of the site, but radiocarbon dates indicate that, despite its similar appearance from place to place, the gray unit probably consists of several chronologically distinct sediment bodies. No known deposits older than about 7600 BP were exposed within the site, and the complex series of vertical and lateral erosion and aggradation cycles documented within T2 probably occurred in the period between 7600 BP and perhaps 3000 BP. Sediments in the vicinity of the Barnes site of terminal Pleistocene and early Holocene age, having the potential to contain Paleoindian age artifacts, most likely exist (if at all) farther from the arroyo channel and closer to the valley wall.

Early Cultural Components

Close examination of the Folsom point fragment found on the site surface indicates that it has been geologically transported and was therefore found out of context, possibly occurring as a part of the Late Prehistoric component at the site. None of the other purported Paleoindian age artifacts in the surface collection have convincing early technological features. These conclusions are consistent with geologic findings that Paleoindian age sediments do not occur anywhere in the investigated area within a depth of about 1.5 to 2.0 meters from the present site surface.

There is strong evidence, both from excavation as well as from closer study of the surface collection, that the artifacts found deep within backhoe Trench A in 2000 are Late Prehistoric in age and found their way to that location through rodent disturbances. Evidence for Archaic age archaeology, consistent with the age of deeper site sediments, is extremely sparse. This occurs, possibly, in the form of a few problematic fractured lithic items found in Units 7 and 8 (postdating 4600 BP), and, definitely, in the form of the buried hearth (Feature 10, well-dated at 6800-7000 BP) that had little more than a single burned and broken rock in association.

Despite this relatively bleak picture, Jack Hofman and I examined several Paleoindian artifacts in PCMS and private collections that clearly demonstrate a strong presence of potentially significant terminal Pleistocene age cultural components (Clovis, Folsom, and

slightly younger) within the PCMS property. To fulfill the research potential that such resources may hold, one only need investigate, more systematically, the pertinent collections and sites.

Comments on the Late Prehistoric Component

There is no question that the Late Prehistoric component at the Barnes site is significant, from a National Register eligibility perspective, because of its great potential to provide new information about human activities in this area several hundred years in the past. Its potential was evident at the time of discovery and survey (Owens 2000), and it is only enhanced by addition of new information from the current program.

The scope and size of the systematic, controlled surface collection was greatly expanded, to a count of more than 700 specimens, during the course of this project. In addition, the excavation program revealed a great deal more about the nature of the Late Prehistoric component. That picture will continue to grow in clarity as artifacts inventoried here and under study elsewhere are more fully researched. The surface-most three excavation levels produced a substantial artifact collection consisting of (excluding artifacts found in and near Feature 5) 343 pot sherds, 280 pieces of flaking debris, 115 pieces of burned bone (mostly very small unidentifiable fragments from what are thought to be medium to large mammals), 33 stone tools, 17 pieces of fire-cracked rock, eight fragments of burned earth, and two small fragments of possible red ochre. Had these upper three levels been completely processed with fine-screen recovery, we would have collected an estimated 936 flakes. Lab workers reported abundant size G5 flakes in many near-surface samples, pointing to the potential for study of spatial patterns in stone tool maintenance activities on the site. Excavation also exposed remnants of three Late Prehistoric hearth features and one pit feature. All of the hearths were partially if not severely eroded, and artifacts in the Late Prehistoric component were clearly concentrated in what appears to be a deflation lag very near the present ground surface. Of the enumerated artifacts, roughly 76% occurred in the first excavation level (within about 10 cm of the current surface), and 97% within the first two excavation levels (within about 20 cm of the current surface). The Late Prehistoric component is well-dated to circa 700 BP.

The above observations are pertinent to planning future excavations and research at the Barnes site. Future excavations focusing only on the Late Prehistoric component will not have to go deeper than about 20 cm below surface, except in locations of deep features such as pits, in order to capture virtually all of the artifacts in that component. More significantly, our excavation data demonstrate the extreme vulnerability of the Late Prehistoric component, with most of its content lying directly at or just beneath the present ground surface. The fact that three hearth remnants were encountered in our spatially restricted tests indicates that such features are probably very common within the site, and that spatial integrity still exists within the Late Prehistoric component. Such features and structure can easily be destroyed, however, by continuing mechanized equipment traffic and surface erosion accelerated by such activities. The vulnerability of the near-surface features and artifacts is demonstrated by recovery of both the Folsom point and the Amazonite pendant (discussed below) in multiple, recently broken fragments. Mechanized equipment traffic on the site also affects our ability to detect shallow cultural features due to extreme compaction of the upper 30 cm or so of the sediment mantle.

Our inability to detect the outline of Feature 5, a very significant pit, at a depth less than 30 cm below surface is probably a direct result of compaction of near-surface sediments.

While the scope of this project and report does not include study of the Late Prehistoric age artifacts, I can nonetheless pass along some specific observations or comments that may be relevant to future studies.

When examining the surface collection, I became curious about the raw material in a very unusual fragmentary, blue-green stone pendant. This item was collected in two parts under a single FS number (FS 007, probably suffering from recent tank damage). I sent the artifact to Bruce Ahler, an experienced hard rock exploration geologist with a strong background in mineralogy, and asked if he could identify the stone type. He determined that it was a mineral called Amazonite, which is a variety of feldspar that receives its unusual color from trace amounts of other minerals that include copper or iron. Bruce stated that Amazonite was a semi-precious gem stone with a few documented source locations around the world, and that a major source for Amazonite was known in the Pikes Peak area of Colorado (Ahler 2001a).

A search on the Web quickly demonstrated to me that Amazonite is well-known in gem and mineral collecting circles. At the web site http://www.minerals.net/mineral/silicate/tecto/feldspar/microcln.htm I learned that Amazonite is a variety of microcline, potassium aluminum silicate ($KAlSi_3O_8$), which is part of the potassium feldspar group. From the same web site:

> "The variety Amazonite comes from several areas in Brazil, India, Madagascar, and Russia. Some of the finest material is from the Pikes Peak area in Colorado. This region encompasses a large area in El Paso, Teller, and Douglas counties. Particularly exceptional deposits in this area include Pikes Peak, Crystal Peak, and Devils Head. Although some of the deposits are quite distant from each other, all material from this area is usually called "Pikes Peak Amazonite", as all the material from this area is identical. Amazonite with beautiful coloring comes from Amelia Court House, Amelia Co., Virginia, although it lacks the crystalline form of the Colorado type. Two other Amazonite localities are Fairfield, Utah Co., Utah, and Mineral Hill, Media, Delaware Co. Pennsylvania."

Encouraged and enthused by this information, I asked Bruce to examine three white stone beads in the surface collection and determine, if possible, what they were made of. These beads (FS 517, 556, 570) are similar in every apparent respect to the hundreds of stone beads found during excavation in Feature 5. I suggested that it was acceptable to fracture one of the specimens if necessary to better determine its properties. Bruce and several fellow geologists examined the beads and provided the following observations:

> "The properties of the beads that we observed were:
> 1. All [three] beads appeared to be made from a similar material.
> 2. Bead FS-570/5LA9187 was easily scratched by a knife blade.
> 3. A fresh broken surface of bead FS-570/5LA9187 showed the bead to be composed of a white, fine crystalline mineral with a high index of refraction (lots of reflection).

4. A small piece of bead FS-570/5LA9187 effervesced rapidly when placed in dilute hydrochloric acid.

"The conclusion is that the bead is composed of very fine crystalline calcite ($CaCO_3$), probably the variety called onyx. Other similar forms of calcite are travertine and dripstone.

"Onyx is formed in low temperature environments such as caves or warm, thermal springs. It has a very compact, dense, massive form and is easily carved. Travertine is chemically the same and is formed in similar environments but is usually colored tan, brown, pink or red from traces of other minerals. Travertine typically has a banded or thinly laminated appearance whereas onyx tends to be more massive. No banding could be seen in these beads but they may be too small to show banding originally present in the parent material (Ahler 2001b)."

Subsequent to this input, Roche Lindsey indicated to me (Lindsey 2002) that, working with Joan Francis Mathien, an expert in the study of Chacoan beads, he had analyzed 230 of the Barnes site beads in detail and determined them to be made of shell (presumably marine shell). Regarding the possibility of shell, Bruce Ahler (2002) indicted that X-ray diffraction might be a useful tool for differentiating shell from stone through detection of calcite and aragonite, similar but distinct forms of $CaCO_3$ that may occur in differing proportions in shell versus dripstone carbonates.

One complete organic bead and small fragments of several others were sorted from the heavy fraction component of the bulk matrix float sample from Feature 5 (Cat. No. 1185) that was processed in the PCRG lab. These appeared to be seeds of some kind, based on their longitudinally asymmetric shape and uniform wall thickness. One end of the complete bead appeared to have been perforated by grinding, and the other was perforated in a different, irregular manner. Southwestern archaeologist Phil Geib examined these specimens and identified them as juniper seed beads. He further stated that the Navajos still make and use beads much like the ones from Barnes. Typically, the Navajos gather juniper seeds in large numbers from abandoned seed caches made by small rodents. When collected in this fashion, the outer soft part of the juniper berry is already missing, and the rodents have gnawed open the more pointed end of the seed and consumed the interior, leaving the empty seed shell. The opposite end of the hollow seed shell is then perforated by grinding and the seed is strung as a bead (Geib 2002). The complete Barnes specimen we examined clearly bears the rodent gnaw marks on one perforated end, indicating that a very similar process was probably used to procure and fabricate the Barnes bead(s).

Another enigmatic feature in the Barnes site Late Prehistoric assemblage is the presence of several very small, heavily burned fragments of medium to large mammal bone that resemble human cranial bone. The fragments typically exhibit two uniformly slightly curved, parallel external surfaces that are quite compact and dense, with porous or cancellous bone at the interior between these two surfaces. One specimen exhibits an unclosed suture line, and one has only one outer surface with the opposite surface fractured away, exposing cancellous tissue. The specimens reminded me of bone in the vault of a human cranium, where interior and exterior

walls are curved and essentially parallel. All these specimens are quite small, and the provenience and size of the fragments in question is as follows:

Unit 14, Level 1.	Cat No. 1110.	2 G3 fragments 1 <G3 fragment
Unit 13, Level 1.	Cat No. 1119.	2 or possibly 3 G3 fragments 1 <G3 fragment
Unit 10, Level 1.	Cat No. 1195	1 G4 fragment 1 G5 fragment

An approximately equal number of similar-sized, burned bone fragments that do not exhibit such morphological features occur in these same contexts.

To gain a more informed opinion on these specimens, I sent them to Carl Falk, a specialist in non-human vertebrate materials in archaeological sites, and Carl in turn also sent them to Dr. Richard Jantz of the Department of Anthropology, University of Tennessee-Knoxville, a specialist in the study of human skeletal remains. These two persons, as well as some other individuals invited by Jantz to examined the bones, concurred in their opinions: The origin of the specimens is indeterminate, due to their small size and fragmentary condition. They could be human, but they could also be non-human materials, such as from the cranium or scapula of a medium-sized artiodactyl such as pronghorn.

My own opinion is that these burned bone specimens remain problematic, and they point to the need for systematic recovery and continued close examination of vertebrate remains should additional fieldwork occur at the Barnes site.

Finally, I can note the continuing unresolved question surrounding the general absence of large mammal bone, except in burned condition, at the site. Virtually all bone fragments that might derive from medium to large mammals exist only in burned condition in the excavated samples (and I believe none of these fragments is taxonomically identifiable). In contrast, all of the unburned bone appears to derive from rabbit or smaller-sized animals. In addition, virtually all of the unburned bone, including a femur that I recollect seeing in the upper fill of Feature 5 and an isolated incisor (both possibly rabbit bones), occur in what appears to be a highly chemically degraded condition. Bone mass in these specimens has been eaten away, from the surface inward. The nature of the archaeological lithic assemblage, containing many impact-fractured arrowpoints as well as hide working tools, strongly indicates close association with an antelope or bison kill/processing event. From this, large amounts of medium to large mammal bone debris can be inferred to have once been present on the site. The surface collection and excavated data indicate that unburned bones (including very durable elements such as teeth) have been systematically removed from the record by some unknown process. It would be very useful to understand such a process, if this is in fact occurring. The answer probably relates to some combination of chemical and microbial properties of the sediments at the site. So far, I have not been able to learn much that bears on the answer to this important problem.

Recommendations

The final section in the report prepared after the close of fieldwork (Ahler and Hofman 2001:25-27) offered a series of nine detailed recommendations regarding future management and research at the Barnes site. Without repeating them here, I will reconfirm seven of these recommendations as previously stated in that document (Items 1-4 and 7-9). Items 5 and 6, which deal with examination of the surface collection for early artifacts and various aspects of geological studies, have been met through the completion of the current report.

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APPENDIX A. REPORT OF THE GEOPHYSICAL INVESTIGATIONS AT SITE 5LA9187, PINON CANYON MANEUVER SITE, LAS ANIMAS COUNTY, COLORADO

Steven L. De Vore

Report of the Geophysical Investigations
at Site 5LA9187,
Pinon Canyon Maneuver Site,
Las Animas County, Colorado

Steven L. De Vore
Midwest Archeological Center
National Park Service
Lincoln, Nebraska
August 2001

Submitted to David Kuehn Consulting, El Paso, Texas

Survey area: 20 by 40 meter area of Site 5LA9187 adjacent to drainage near the head of Lockwood arroyo (Figure 1).

Surface features: None noted. Site identified from surface lithic and ceramic scatter. Site contained Folsom point fragments as well as Late Prehistoric projectile points.

Subsurface features: None observed in cutbank of drainage.

Survey methodology: The survey was conducted at the request of the New Mexico State University archeological team. The archeological team was conducting an inventory of sites in Training Area 10 on the U.S. Army's Pinon Canyon Maneuver Site during the summer of 2000. The Folsom point fragments suggested the possibility of a buried Folsom component at the site. The geophysical survey, including magnetic gradient, electromagnetic conductivity, and magnetic susceptibility surveys, was conducted to determine the presence of buried cultural features and stratigraphic zones surrounding an area selected for geoarcheological investigations with a backhoe trench. The geophysical grids were laid out perpendicular to the drainage with a portable transit. Wooden hub stakes were placed at the 20-meter grid corners. Twenty-meter ropes were placed along the north-south lines connecting the grid corners. These ropes formed the east and west boundaries of each grid during the data collection phase of the survey. Additional ropes were placed at one-meter intervals across the grid in an east-west orientation. These ropes served as guides during the data acquisition. The ropes were marked with different color tape at half-meter and meter increments designed to help guide the survey effort.

Survey grid: 2 complete 20 by 20 meter grids at 0.5 meter intervals.

Instrument: Geoscan Research FM36 fluxgate gradiometer
Specifications: 0.05 nT (nanotesla) resolution, 0.1 nT absolute accuracy.

Survey type: gradiometer

Operator: Steven De Vore

A magnetic gradient survey is a passive geophysical survey (see Bevan 1998:18-29; Clark 1996:64-98; Heimmer and De Vore 1995:7-20 for more details of magnetic surveys). The instrument is a vector magnetometer, which measures the strength of the magnetic field in a particular direction. The sensors must be accurately balanced and aligned along the direction of the field component to be measured. The zero reference point was located to the south of the southwest corner of the geophysical grid. The two magnetic sensors in the instrument are arranged at approximately 0.5 meters apart. The instrument is carried so the two sensors are vertical to one another. Each sensor reads the magnetic field strength at its height above the ground. The gradient or change of the magnetic field strength between the two sensors is recorded in the instrument's memory. This gradient is not in absolute field values but rather voltage changes, which are calibrated in terms of the magnetic field. The fluxgate gradiometer does provide a continuous record of field strength.

Its application to archeology results from the effects of magnetic materials on the earth's magnetic field. These anomalous conditions, which depart from the uniform magnetic field generated by the earth, result from magnetic materials and minerals buried in the soil, or underlying bedrock. Iron artifacts have a very strong effect on the earth's local magnetic field. Other cultural features that also affect the earth's local magnetic field include fire hearths and soil disturbances, (e.g., pits, mounds, wells, pithouses, dugouts, etc.). Geological features, such as iron ore deposits, also affect the earth's magnetic field.

The magnetic gradient survey was designed to collect 8 samples per meter along 0.5-meter traverses or 16 data values per square meter. The data were collected in a parallel fashion with the surveyor traveling in the same direction for each traverse across the grid. A total of 6,400 data values were collected for each 20 by 20 meter grid. The magnetic data were recorded in the memory of the gradiometer and downloaded to a laptop computer at the completion of the survey. The magnetic data were imported into Geoscan Research's GEOPLOT software for processing. Both shade relief and trace line plots were generated in the field before the instrument's memory was cleared. The grids were combined to form a composite file and a zero mean traverse was ran to remove stripping effects resulting from data acquisition errors. The function also helps remove any edge discontinuities that may have occurred from the electronic drift of the instrument during the survey period. The data was then exported as an ASCII *.dat file and placed in the Surfer for Windows mapping program. The data were gridded and both an image map (Figure 2) and an image map with the magnetic contour lines overlain on the raster image plot (Figure 3) were generated.

The magnetic data range from –8.6698 nT to 6.1986 nT with a mean of 0.011 nT and a standard deviation of 1.087 nT. The area is relatively quiet as far as magnetic surveys are concerned. The magnetic data set clearly shows magnetic high extending across the grid from N100/E120 to the N120/E125 (Figure 4). This is a geologic feature that is associated with a slight elevational change between the T2 and T3 terraces at the site. A relatively strong dipole anomaly near N110/E130 is a metal fragment from a military tracked vehicle. In addition, numerous linear anomalies in the eastern portion of the grid represent tracks of military vehicles, which use the area for mechanized training.

Instrument: Geonics EM38 electromagnetic conductivity meter

Specifications: apparent conductivity of the ground in millisiemens per meter (mS/m); measurement precision ±0.1% of full scale deflection; 100 and 1000 mS/m conductivity ranges (4 digit digital meter).

Survey type: conductivity in the quadrature phase operating mode

Operator: Steven De Vore

The conductivity survey is an active geophysical technique, which induces an electromagnetic field into the ground through a transmitting coil (see Bevan 1998:29-43; Clark 1996:33-37; Heimmer and De Vore 1995:35-41 for more details of conductivity surveys). The induced primary field causes an electric current flow in the earth similar to a resistivity survey. In fact, a conductivity survey is the inverse of a resistivity survey. High conductivity equates to low resistivity and vice versus. The materials in the earth create secondary eddy current loops, which are picked up by the instrument's receiving coil. The interaction of the generated eddy loops or electromagnetic field with the earthen materials is directly proportional to terrain conductivity within the influence area of the instrument. The EM38 conductivity meter has a depth of investigation of approximately one meter in the vertical dipole mode. The readings are stored in the data logger attached to the conductivity meter until downloaded to a lap-top computer.

Its application to archeology results from the ability of the instrument to detect lateral changes on a rapid data acquisition, high resolution basis, where observable contrasts exist. Lateral changes in anthropogenic features result from compaction, structural material changes, buried metallic objects, excavation, habitation sites, and other features affecting water saturation (Heimmer and De Vore 1995:37).

The conductivity survey was designed to collect 2 samples per meter along 0.5-meter traverses or 4 data values per square meter. The data were collected in a zig-zag fashion with the surveyor alternating the direction of travel for each traverse across the grid. A total of 1,600 data values were collected for each 20 by 20 meter grid. The data were converted to XYZ coordinates in the Geonics DAT38 software. The data were placed in the Surfer for Windows mapping program. The data were gridded and both an image map (Figure 5) and a contour map overlain on the raster image data (Figure 6) were generated.

The data ranged from 9.096 mS/m to 89.916 mS/m with a mean of 26.614 mS/m and a standard deviation of 18.756 mS/m. The conductivity data have a high correlation with the topographic setting in the grid (Figure 7). Near the edge of the grid on the T1 terrace, the conductivity is at its highest in the lowest topographic elevation above the drainage. Between the T1 and T2 terraces, the conductivity values gradually drop until they level out on the T3 terrace above the drainage. There is approximately two meters change in elevation from the edge of the arroyo bank to the eastern boundary of the grid. The conductivity variation appears to represent changes in the moisture content of the soil, as well as, textural and structural changes in the soil between the three terrace settings above the drainage.

Instrument: Geonics EM38 electromagnetic conductivity meter

Specifications: in phase response in parts per thousand (ppt) of secondary to primary magnetic field; measurement precision ±0.1% of full scale deflection; 100 and 1000 ppt susceptibility ranges (4 digit digital meter).

Survey type: magnetic susceptibility in the in phase mode of operation

Operator: Steven De Vore

The magnetic susceptibility survey is an active geophysical technique, which induces an electromagnetic field into the ground through a transmitting coil (see Clark 1996:99-117; Dalan and Banerjee 1998:3-36; Milsom 1996:39-40 for more details of magnetic susceptibility surveys). The induced primary field causes an electric current flow in the earth similar to a resistivity survey. The EM38 responds to the varying magnetization of susceptible materials caused by the primary field acting on them. The EM38 conductivity meter in the vertical dipole mode of operation has a depth of investigation of approximately one meter for the in phase measurements. The readings are stored in the data logger attached to the conductivity meter until downloaded to a lap-top computer.

It application to archeology results from normally greater susceptibility of the topsoil in comparison to the subsoil layers, and the enhancement of this susceptibility by human habitational activities (Clark 1996:99). Thus magnetic susceptibility studies can be used to define site limits, activity areas, or features. Such studies can aid in the investigation of morphology or function of sites, areas, or features, and the cultural and natural processes responsible for their formation. Magnetic susceptibility surveys may also aid our understanding of erosional and depositional processes that contribute to site formation. They can provide climatic data and other information on soil-forming regimes that also affect archeological contexts. Such studies can provide data to assist the construction and correlation of stratigraphic sequences (Dalan and Banerjee 1998:13).

The susceptibility survey was designed to collect 1 sample per meter along each meter traverse or 1 data value per square meter. The data were collected in a zigzag fashion with the surveyor alternating the direction of travel for each traverse across the grid. A total of 240 data values were collected for 40 by 6 meter survey area. The data were converted to XYZ coordinates in the Geonics DAT38 software. The data were placed in the Surfer for Windows mapping program. The data were gridded and both an image map (Figure 8) and a contour map overlain on the raster image data (Figure 9) were generated.

The data ranged from –1.583 ppt to –0.903 ppt with a mean of –1.263 ppt and a standard deviation of 0.104 ppt. The susceptibility data values have a limited correlation with the topographic setting in the grid (Figure 10). Along the rise from the T1 to the T2 terrace, the susceptibility values peak between E110 and E115. This peak suggests a break in the soils between the two terrace settings. If more of the grid had been surveyed, it is probable that better

correlation between soil formation properties and the magnetic susceptibility could have been established.

Conclusions: On August 17, the Midwest Archeological Center conducted geophysical investigations of a portion of Site 5LA9187 at the U.S. Army's Pinon Canyon Maneuver Site, Las Animas County, Colorado. The project was conducted for the New Mexico State University archeological team inventorying Training Area 10 on the maneuver site. During the investigations, 800 square meters of the site adjacent to an upland drainage flowing into Lockwood Arroyo were surveyed with a Geoscan Research FM36 fluxgate gradiometer and a Geonics EM38 electromagnetic conductivity meter in the quadrature phase and in phase modes of operation. The magnetic gradient data (Figure 11) suggest an area of higher magnetic values near the break between the T2 and T3 terraces above the drainage. The conductivity data shows a decrease in conductivity as one moves away from the bank edge across the terraces. The magnetic susceptibility data indicated a relative high susceptibility anomaly at the break between the T1 and T2 terraces.

Although limited in areal coverage of the site, the geophysical methods utilized for this investigation have demonstrated their potential for revealing information about site formation processes. The project was conducted in advance of the placement of a backhoe trench in the site to identify stratigraphic sequences in the site formation processes. The data provided the geoarcheologist with information to assist in the placement of the backhoe trench. These geophysical investigations have indicated that such investigations can provide valuable information on site formation processes and cultural activities. Their application on future projects should be a major consideration in the planning process.

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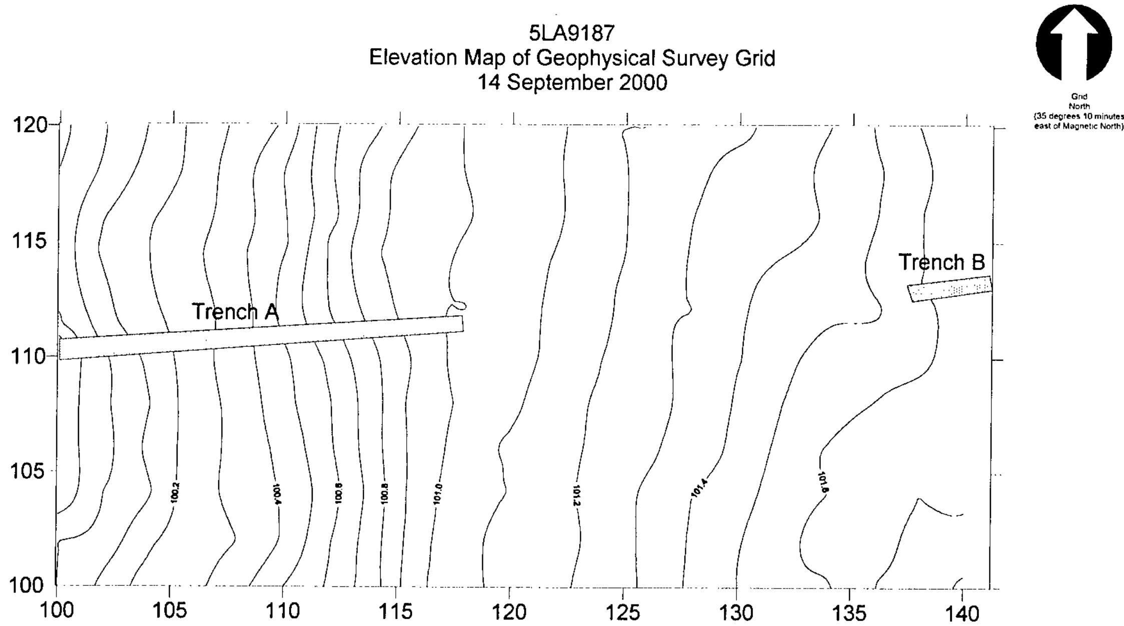

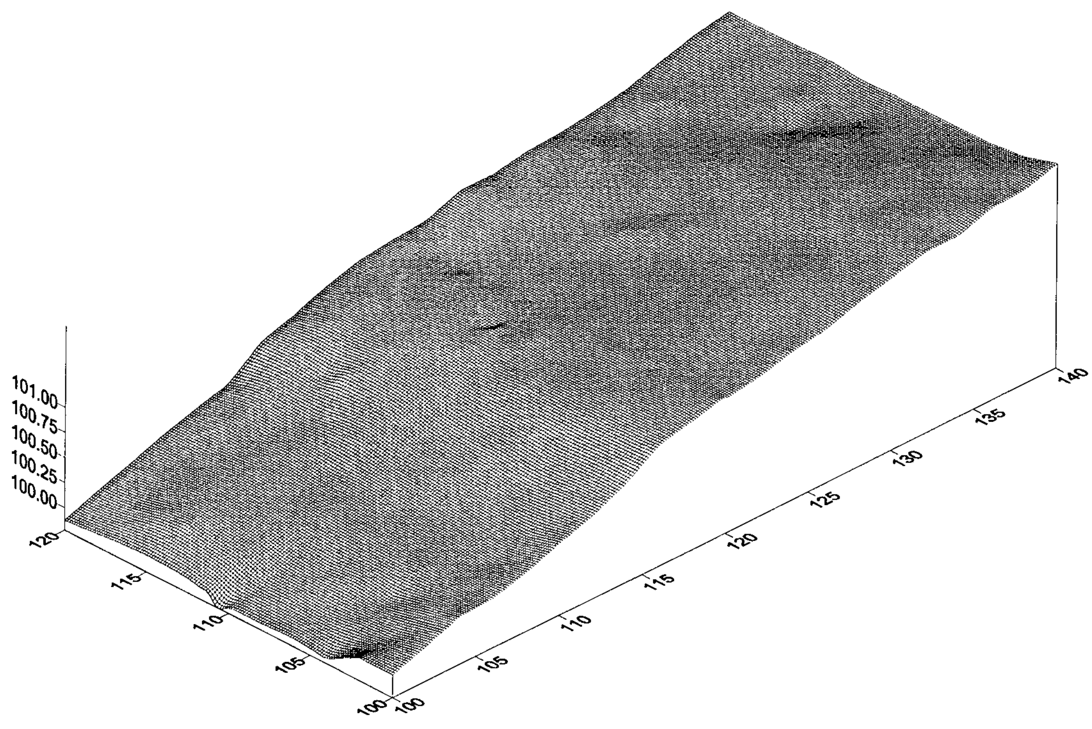

Figure 1. Elevation Map of the geophysical grid in both contour interval and surface relief views.

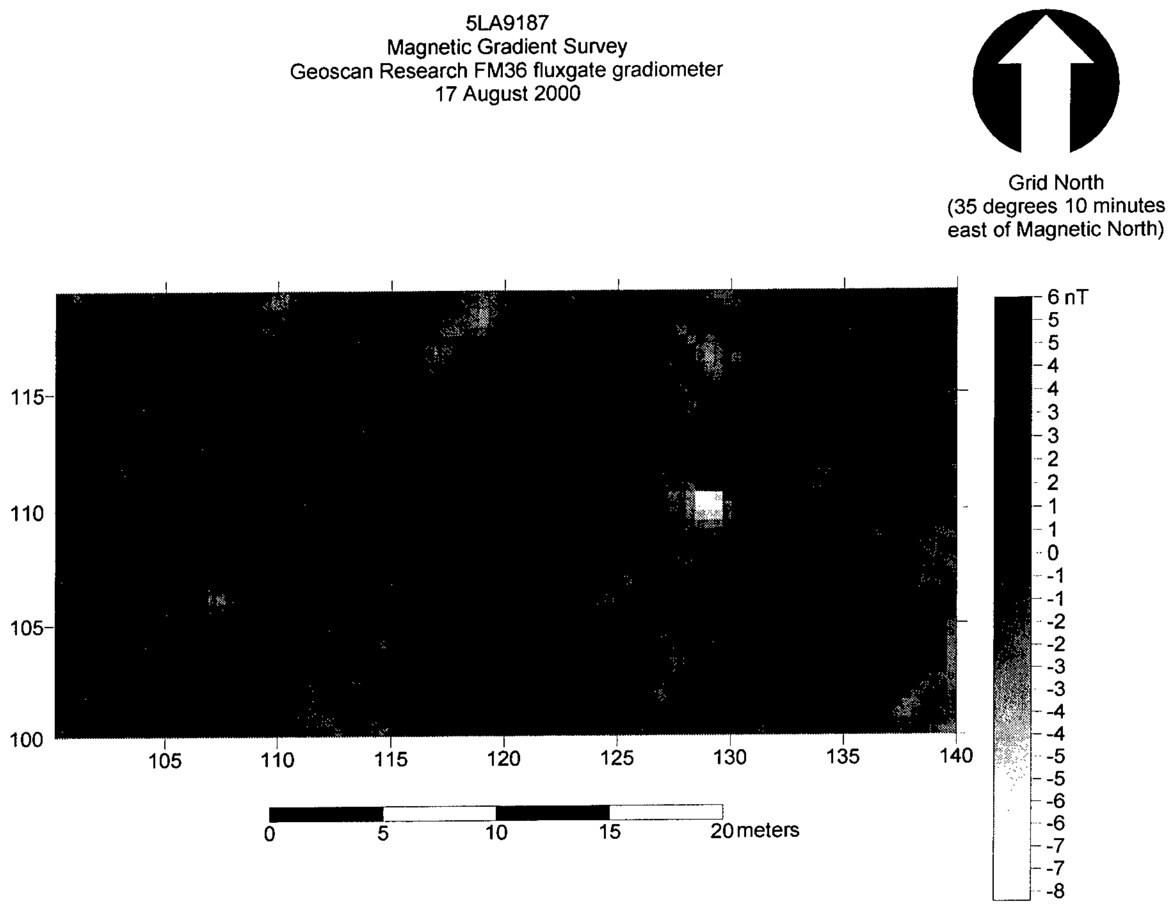

Figure 2. Magnetic Gradient Data of the Geophysical Grid at 5LA9187.

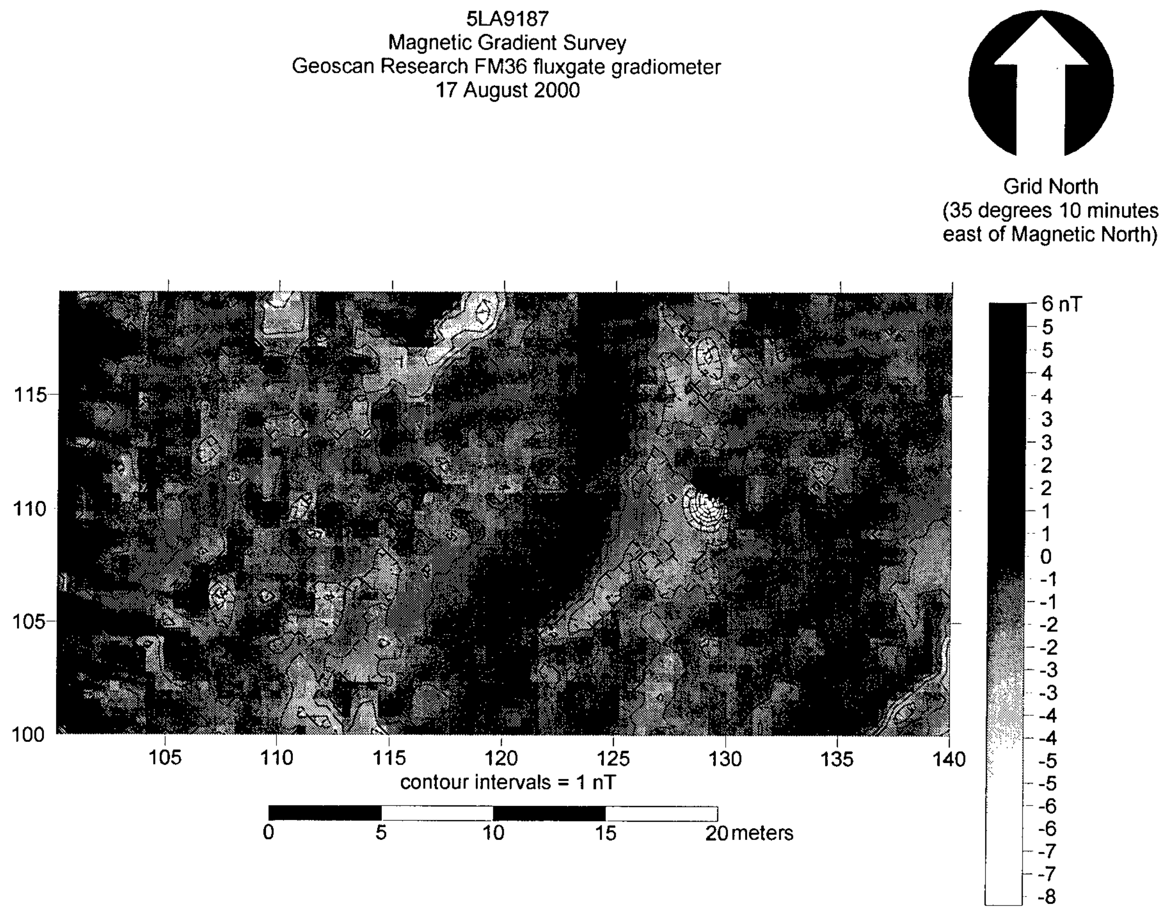

Figure 3. Raster Plot of Magnetic Data Overlain with Magnetic Contour Data.

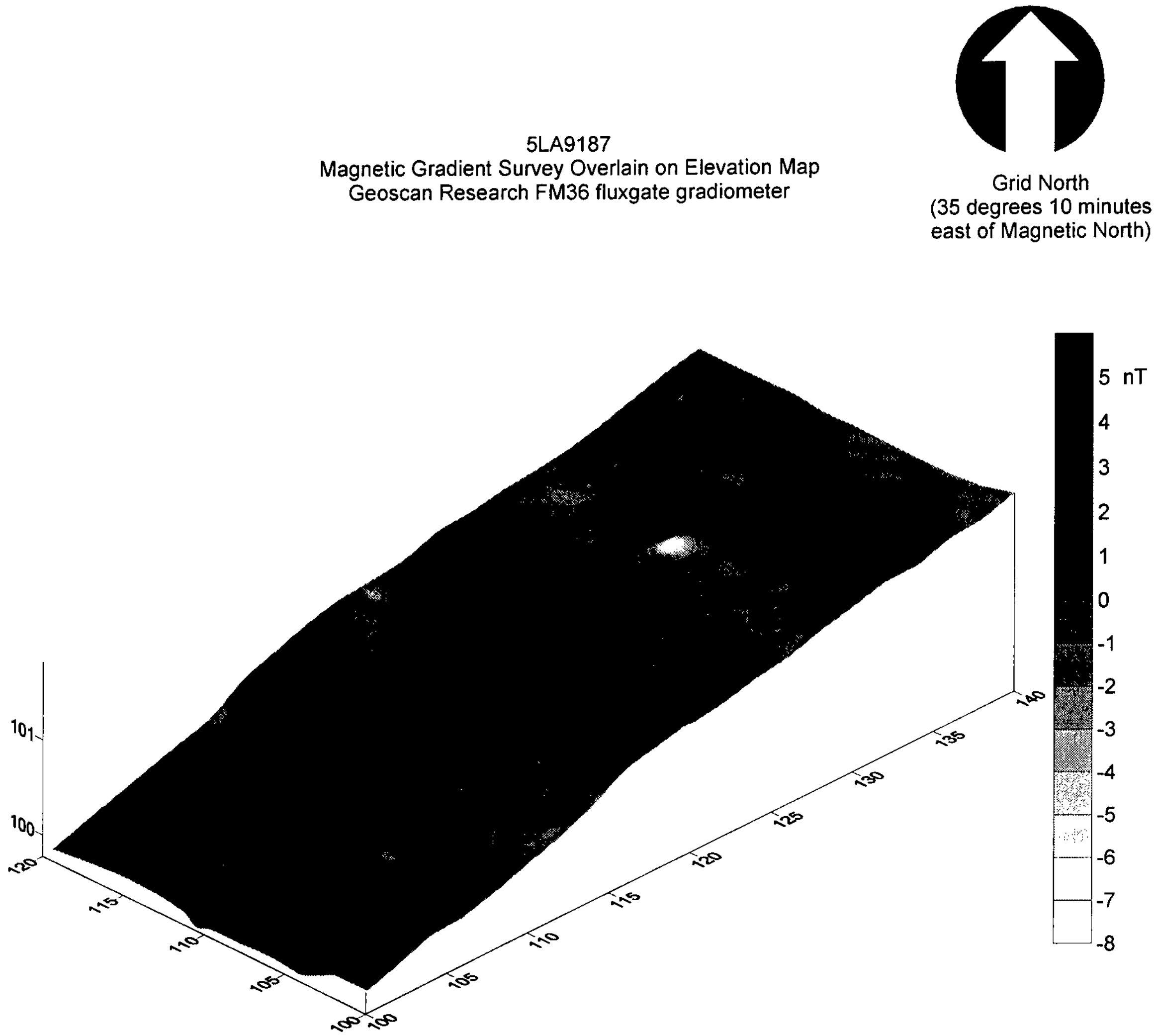

Figure 4. Magnetic Gradient Data Overlain on Geophysical Grid Elevation Surface Relief.

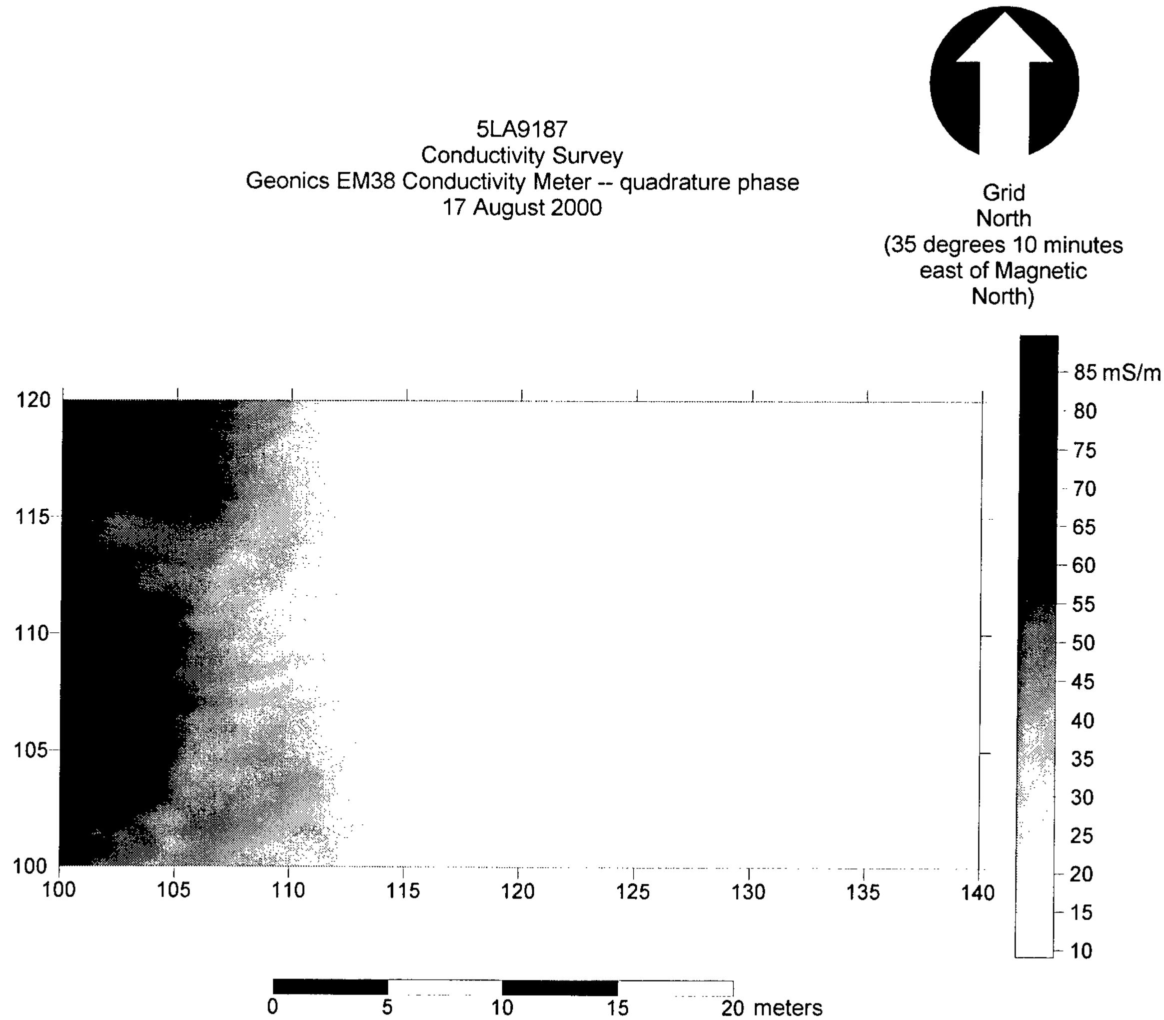

Figure 5. Conductivity or Quadrature Phase Data of the Geophysical Grid at 5LA9187.

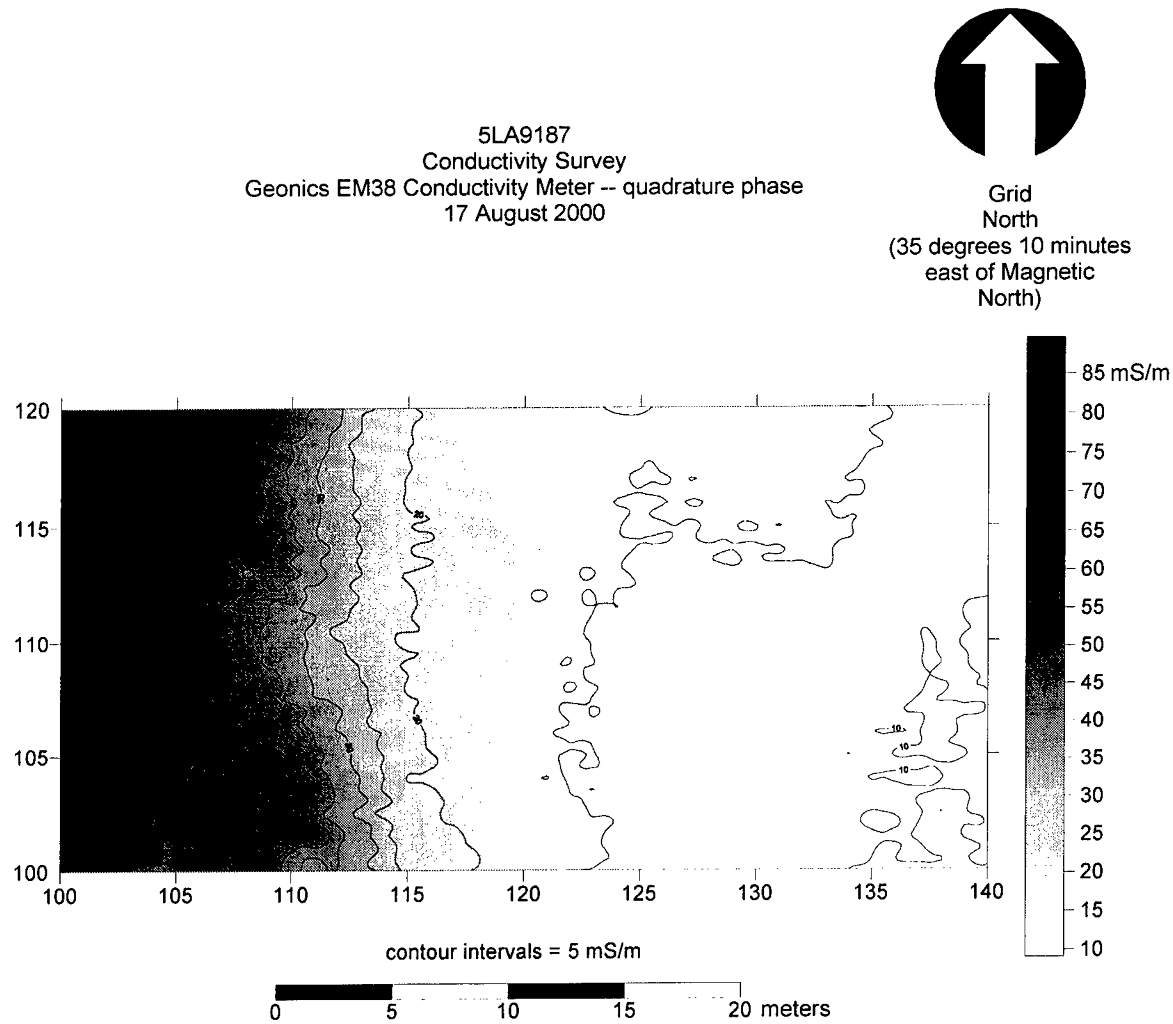

Figure 6. Raster Plot of Conductivity or Quadrature Phase Data Overlain with Conductivity Contour Data.

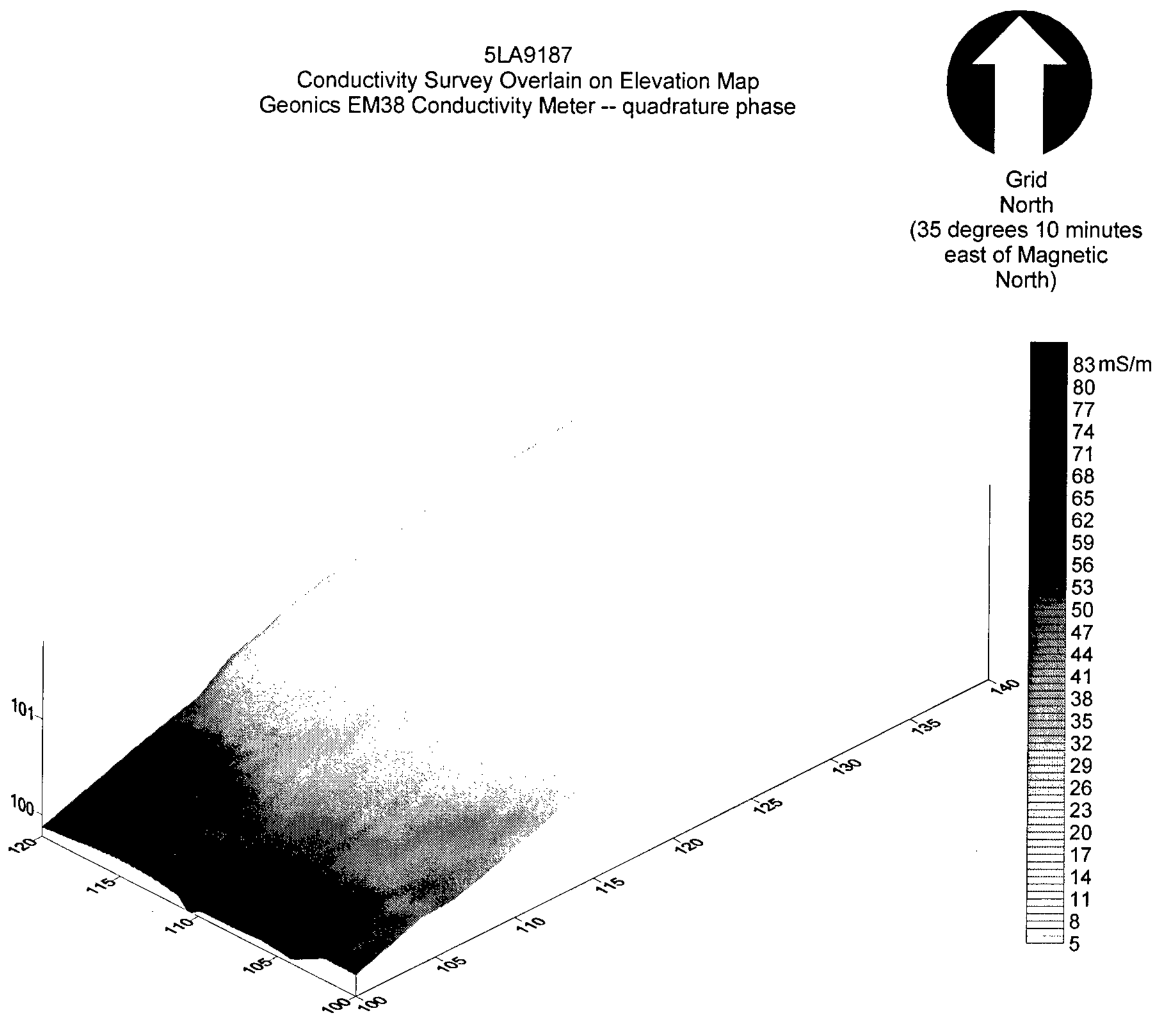

Figure 7. Conductivity or Quadrature Phase Data Overlain on Geophysical Grid Elevation Surface Relief.

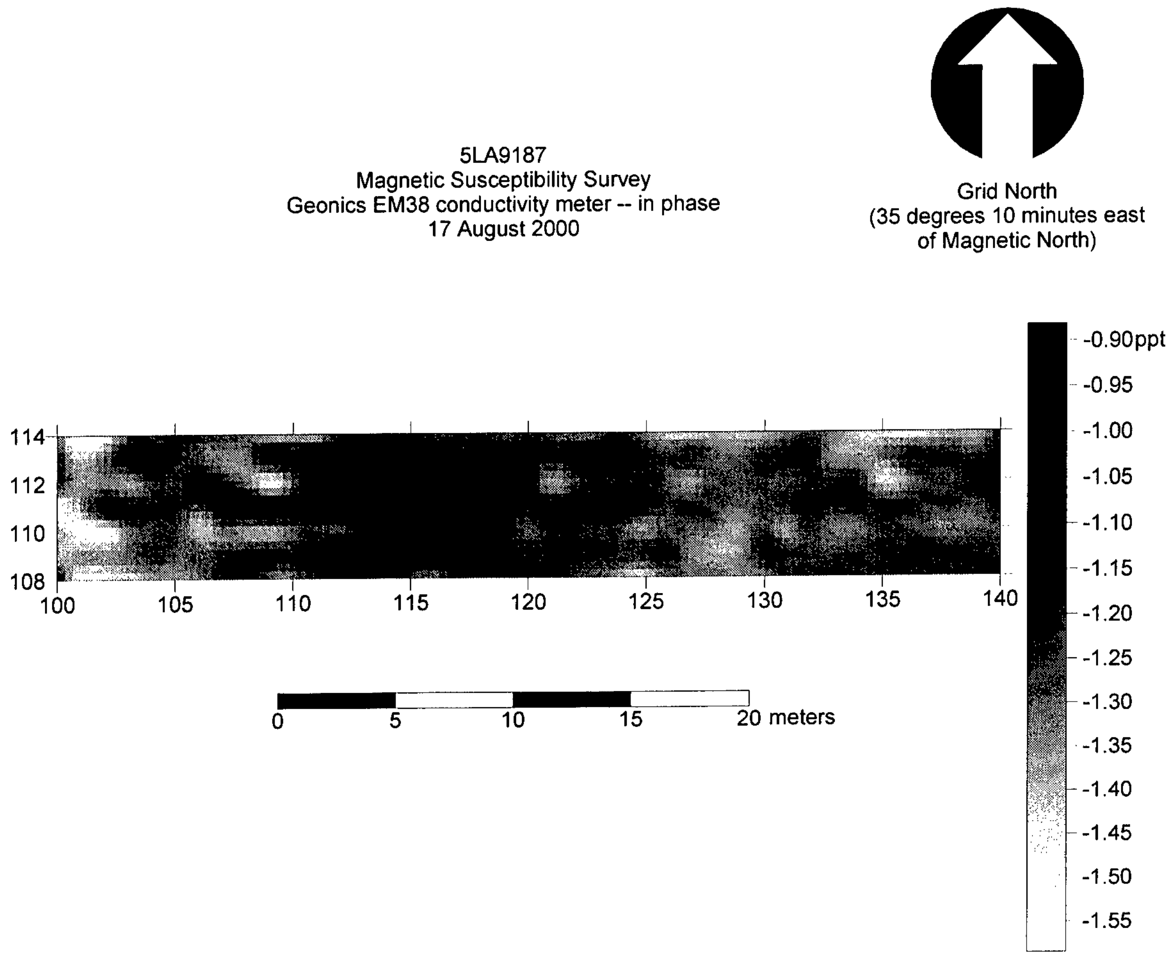

Figure 8. Magnetic Susceptibility Data of the Geophysical Grid at 5LA9187.

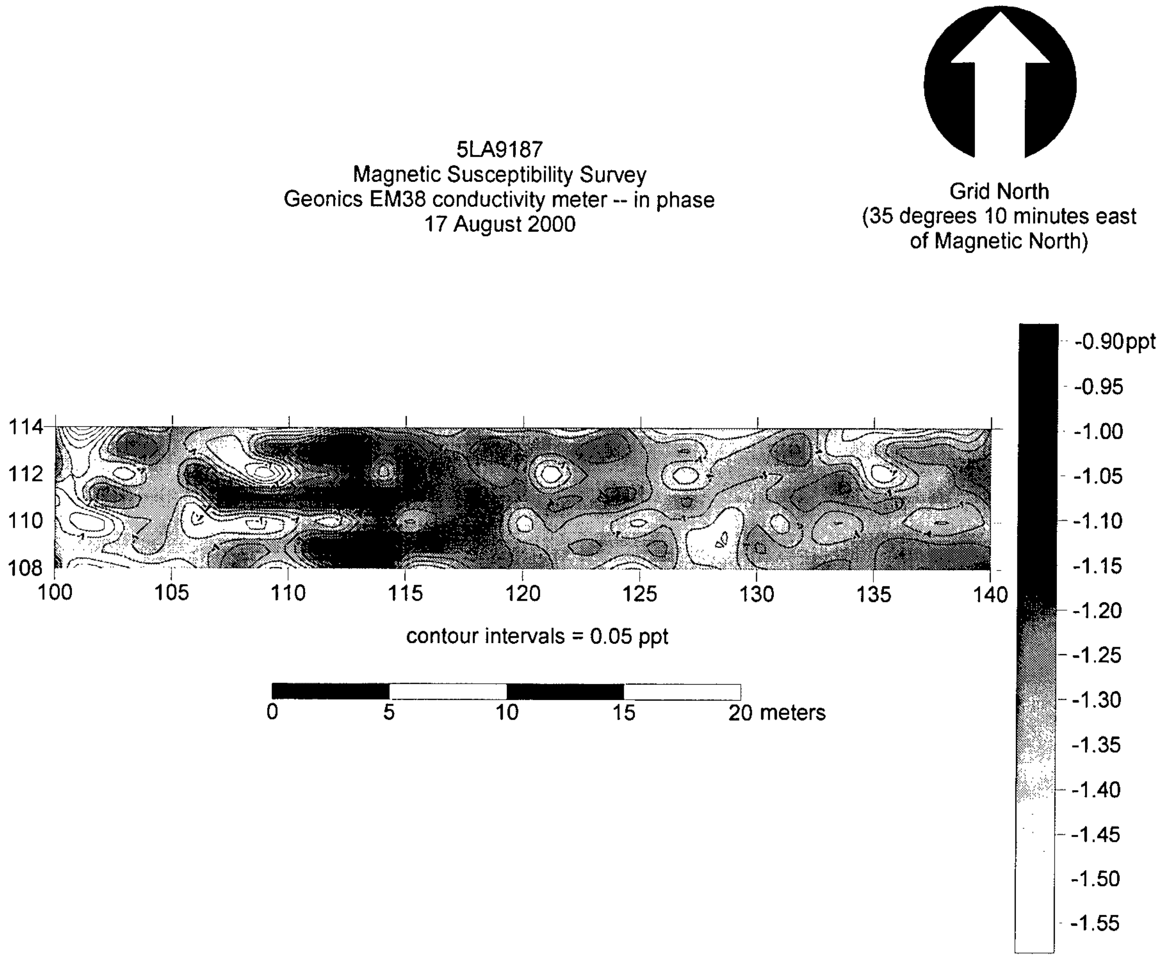

Figure 9. Raster Plot of Magnetic Susceptibility Data Overlain with Susceptibility Contour Data.

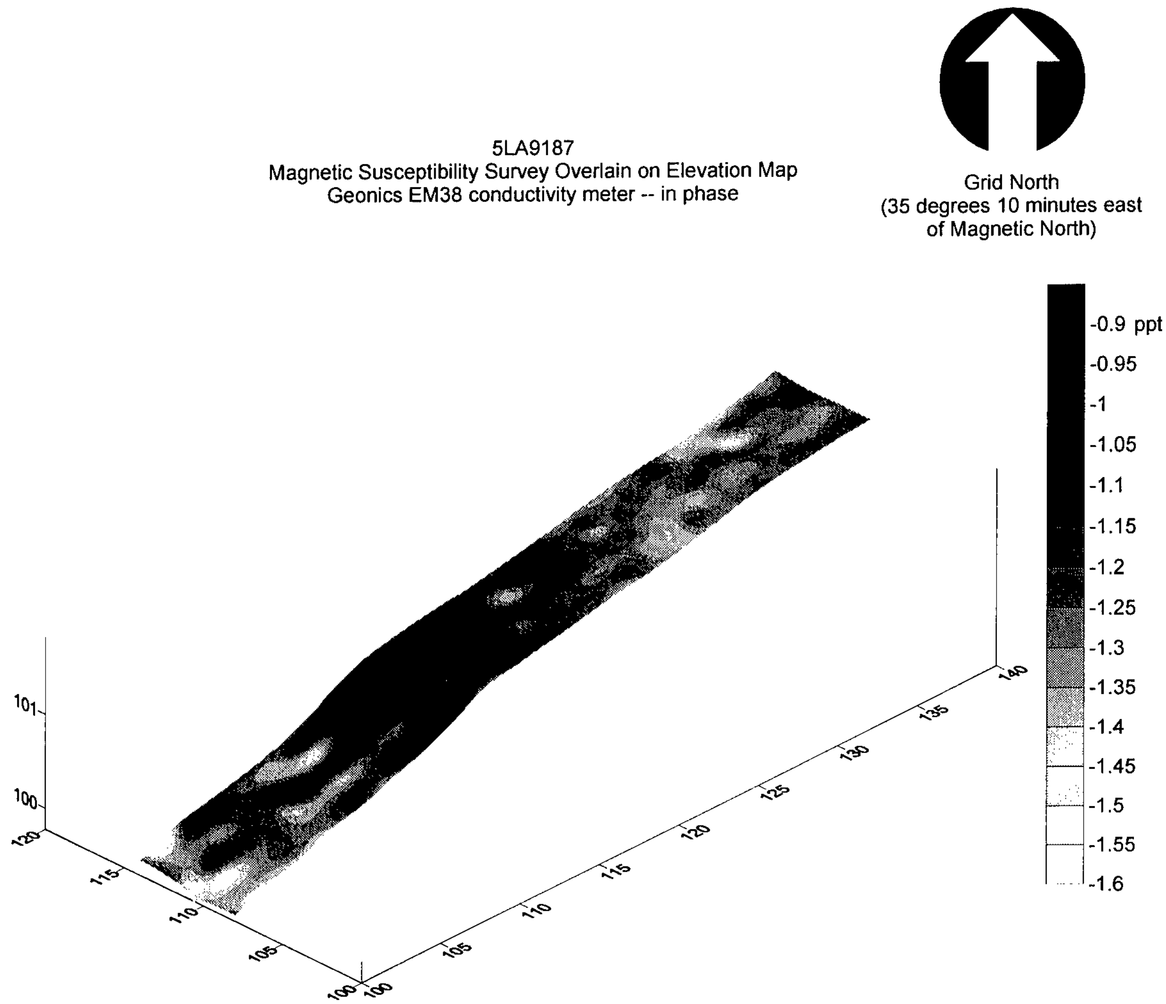

Figure 10. Magnetic Susceptibility Data Overlain on Geophysical Grid Elevation Surface Relief.

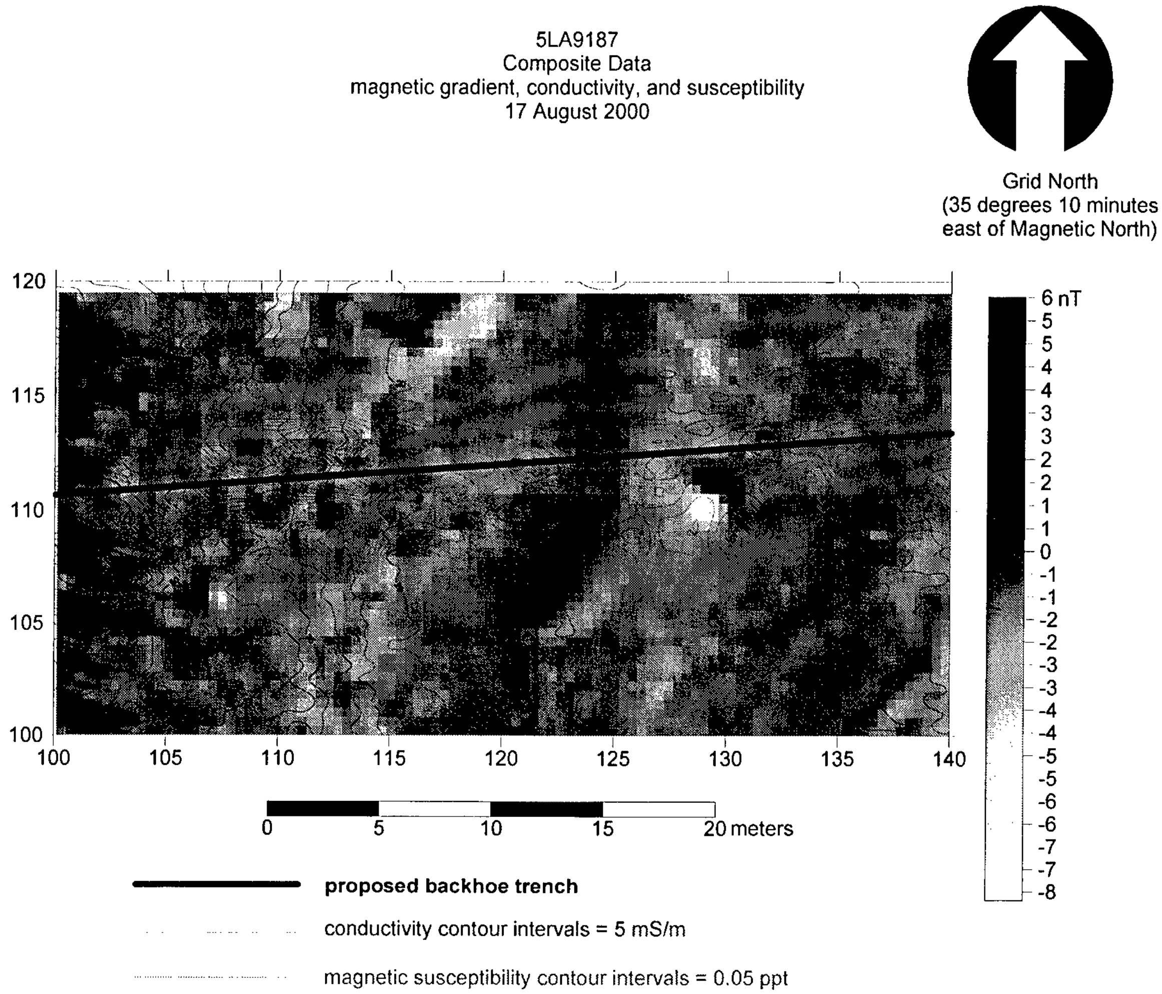

Figure 11. Composite of Magnetic Gradient Data with Conductivity and Susceptibility Contours.

APPENDIX B. MAGNETIC SUSCEPTIBILITY INVESTIGATIONS AT THE BARNES FOLSOM SITE (5LA9187), PINON CANYON MANEUVER SITE, LAS ANIMAS COUNTY, COLORADO

Steven L. De Vore

Magnetic Susceptibility Investigations at the Barnes Folsom Site (5LA9187), Pinon Canyon Maneuver Site, Las Animas County, Colorado

Steven L. De Vore
National Park Service
Midwest Archeological Center
Lincoln, Nebraska

March 1, 2002

Submitted to: Dr. Stanley A. Ahler, PaleoCultural Research Group, Flagstaff, Arizona

Survey area: Barnes Folsom Site (5LA9187), Las Animas County, Colorado

Surface features: No noticeable features on the surface with the exception of recent tracks from military wheeled and tracked vehicles.

Subsurface features: Late Prehistoric pit with beads, ceramics, and lithics just below the ground surface exposed in Trench 2, as well as, an Archaic hearth at approximately 1.3 meters below the surface exposed in Trench 1C.

Survey grid: archeological/geophysical grid aligned on magnetic north.

Instrument: Bartington MS2 magnetic susceptibility meter with MS2B dual frequency sensor

Specifications: operating frequency for Low Frequency (LF) at 0.465 kHz and for High Frequency (HF) at 4.65 kHz; maximum resolution: 2 X 10^{-7} CGS (HF and LF); accuracy: 1%; HF/LF cross calibration 0.1% worst case; temperature induced drift: not greater the 60.5 X 10^{-6} CGS/minute for ambient temperature fluctuation of 618C/hr.

Survey type: magnetic susceptibility

Operator: Steven De Vore

Introduction

Magnetic susceptibility measures the degree to which a material can be magnetized. It is defined as the ratio of the induced magnetic field in a material to the applied magnetic field. It can be expressed as volume susceptibility (K) where the measurement is normalized by volume or as mass susceptibility (X) where the measurement is normalized by mass. The low field mass susceptibility (X^{lf}) is equal to the volume susceptibility (K) divided by the bulk density of the sample (ρ in units of kg cm^{-3}).

Magnetic susceptibility may be one of the most important but least utilized geophysical investigative techniques in archeological landscape studies. In general, the technique is extremely sensitive to environmental change and is widely used in environmental studies

(Thompson and Oldfield 1986). The techniques for the measurement and interpretation of magnetic susceptibility are derived from the fields of rock magnetism and paleomagnetism (Banerjee 1981; Nagata 1961; Tarling 1983).

Iron oxides are present in most of the earth's soils. The iron is present and magnetically detectable in grains of magnetite, maghaemite, and hematite. These iron minerals in the soil are "susceptible" to becoming magnetized in the presence of a magnetic field (Ellwood et al. 1998). This fundamental property can be quickly and easily measured on small samples.

The application of magnetic susceptibility to archeological prospection centers around two factors: 1) typically, greater susceptibility is found in the topsoil than in underlying subsoil, and 2) human activities associated with site occupation enhances the susceptibility of the topsoil (Clark 1996). The method has been developed to detect evidence of human occupation and defining site limits in the topsoil even when no distinctive features have survived. It can be applied to research questions concerning the following topics: 1) site limits, activity areas, or features; 2) morphology or function of sites, activity areas, and features and their formation processes; 3) the effects of sedimentation and erosion upon the archeological record; 4) establishing and expanding stratigraphic sequences; and 5) climatic regimes and other information on soil-forming factors (Dalan and Banerjee 1998:13). Dalan and Banerjee (1998) provide an overview of the historic and present applications of the techniques to archeological investigations.

While many of the past applications have centered on the areal prospection of the surface, the present project is concerned with the magnetostratigraphy (Clark 1996). This type of project is the magnetic study of the accumulated deposits, which may provide information about the intensity of the occupational level (Yates 1989). The techniques can also be used to correlate stratigraphy across a site, as well as, identify buried soils or paleosols (Dalan and Banerjee 1999).

Methods

The Bartington MS2 magnetic susceptibility meter (Bartington 1989) was used with a MS2B dual frequency laboratory sensor to collect both low and high frequency readings of the sample. The ability of the laboratory sensor to operate at two different frequencies also provided for the study of the frequency dependency of susceptibility of the samples. Soil samples were collected during the 2001 PaleoCultural Research Group (PCRG) and New Mexico State University (NMSU) archeological investigations at the Barnes Folsom Site, 5LA9187 (Figure 1). Soil samples from each magnetic susceptibility column were collected at five-centimeter increments. The samples were placed in plastic zip-lock bags. The low-field mass susceptibility (X^{lf}) samples were collected from the west wall of XU 2 (Figure 2) and from the north wall of backhoe Trench 1A (Figure 3). The magnetic susceptibility column from the west wall of XU2 was located at 1007.5N/1002E. The X^{lf} sample column from XU 2 extended from the surface to a depth of 1.205 m below the surface (bs). In Trench 1A, the X^{lf} samples were taken from the north wall of the backhoe trench at 1003.82N/1012.33E. The X^{lf} sample column from Trench 1A extended from the surface to a depth of 1.745 m bs.

The soil from each magnetic susceptibility sample was packed into a 23-mm cubic plastic box. The samples were labeled with the provenience information, and the lid was sealed with masking tape. They were also weighed in order to calculate their mass specific susceptibility values. The Bartington MS2 system was setup in a low traffic area within the Midwest Archeological Center. The system was also placed on a wooden table away from metal chairs, tables, electrical outlets, etc. This was an attempt to minimize any magnetic effects from other materials or electromagnetic current. The meter was also connected to a laptop computer operating the Multisus for Windows software (Bartington Instruments 1998). The software provided the system with a means to record both the Low Frequency (X_{LF}) and the High Frequency (X_{HF}) susceptibility readings with the LF measurements taken first. The software also performed mass specific susceptibility corrections to the samples and calculated the frequency dependent susceptibility ($X_{fd\%}$). Prior to the processing of the susceptibility samples, an empty cube was placed in the sensor to obtain the susceptibility value of the plastic container, which was used by the Multisus software program to correct the mass susceptibility of the sample. An average of ten measurements of the empty plastic cube yielded a mean weight of 3.0 g and a mean susceptibility measurement of -0.4 Bartington units to establish the correction coefficient for the container.

Initially, the meter was set to zero before a sample was inserted into the MS2B sensor. The sample was measured and the result recorded in the Multisus software program on the laptop computer. The sample was removed from the sensor and a second reading was taken of the empty sensor. The low-field mass susceptibility value (X^{lf}) in the software program was recorded and corrected. These steps were repeated for each sample in the Low Frequency range (X_{LF}) and then in the High Frequency range (X_{HF}). The units of measurement are in the International System's (SI) for mass specific susceptibility ($m^3\ kg^{-1}$). To adjust the Bartington readings to SI values, the readings need to be multiplied by 10^{-8}. Formulas for the calculation of the mass specific susceptibility ($X^{lf} = K/\rho$) and frequency dependent susceptibility ($X_{fd\%} = ((X_{LF} - X_{HF})/ X_{LF}) * 100$) are defined in Dearing (1994:18). The results of the corrected X^{lf} values for the X_{LF}, the X_{HF}, and the $X_{fd\%}$ for the XU 2 samples are in Table 1. Table 2 contains the corrected X^{lf} values of X_{LF} and X_{HF} values along with the $X_{fd\%}$ values for Trench 1A. The resulting data from the susceptibility measurements were placed in Golden Software's GRAPHER software (Keckler et al. 1994) for plotting.

Results of the Low Field Mass Susceptibility

The magnetic susceptibility of soils has a high correlation with the mineralogy of the parent material and local geology (Dearing 1994:48). Soils developed in strongly magnetic basalts have higher X^{lf} values than soils developed in limestone or sandstone. Soils generally have higher X^{lf} values in the topsoils as compared with the subsoils. Magnetic enhancement of the topsoil results from accumulation of primary minerals that are resistant to weathering found in the parent material (Dearing 1994:48-51) and the formation of secondary minerals by burning of soil in the presence of organic matter (Dearing 1994:51), by the addition of dust from industrial combustion processes or volcanic eruptions (Dearing 1994:51), and/or by organic and inorganic chemical processes in the soil (Dearing 1994:51-52). The degree of the magnetic enhancement in the topsoil is controlled by the local geology, the climatic conditions, vegetation and organic matter, soil organisms (i.e., bacteria), and time (Dearing 1994:55-61). Human

activity also has an effect on the susceptibility through heating effects from fires and chemical and bacterial effects on garbage decomposition (Dearing 1994:88-91). Magnetic enhancement also allows the identification of buried soils, characterization of sediments, and identification of source locations.

XU2

Analysis of the data (Table 1) of the susceptibility samples from XU2 revealed an increase of approximately 20 $m^3\ kg^{-1}\ (10^{-8})$ from the surface to a depth of 30 cm bs (Figure 4). The values then drop to approximately 43 $m^3\ kg^{-1}\ (10^{-8})$ at 65 cm bs. At 70 cm bs there is a slight increase in X_{LF} and X_{HF} values. The susceptibility values then decrease to approximately 35 $m^3\ kg^{-1}\ (10^{-8})$ at depth of 95 cm bs; however there is a slight increase in values to approximately 50 $m^3\ kg^{-1}\ (10^{-8})$ at 90 cm bs which correspond to a unconformity in the Gray Unit at the interface between light concentration of carbonates to a more dense concentration of carbonates below. In the lower portion of the profile, the susceptibility values increase to approximately 56 $m^3\ kg^{-1}\ (10^{-8})$ at 1.10 m bs before declining to approximately 40 $m^3\ kg^{-1}\ (10^{-8})$ at the base of the excavation. The X_{LF} values range from 35.4 $m^3\ kg^{-1}\ (10^{-8})$ to 112.9 $m^3\ kg^{-1}\ (10^{-8})$ with a mean of 67.321 $m^3\ kg^{-1}\ (10^{-8})$ and a standard deviation of 27.197 $m^3\ kg^{-1}\ (10^{-8})$. The X_{HF} values range from 35.1 $m^3\ kg^{-1}\ (10^{-8})$ to 111.3 $m^3\ kg^{-1}\ (10^{-8})$ with a mean of 66.483 $m^3\ kg^{-1}\ (10^{-8})$ and a standard deviation of 26.717 $m^3\ kg^{-1}\ (10^{-8})$.

Trench 1A

Analysis of the data (Table 2) from Trench 1A indicates a decrease from a X_{LF} value of 78.4 $m^3\ kg^{-1}\ (10^{-8})$ and a X_{HF} value of 76.8 $m^3\ kg^{-1}\ (10^{-8})$ at the surface to a X_{LF} value of 49.4 $m^3\ kg^{-1}\ (10^{-8})$ and a X_{HF} value of 48.8 $m^3\ kg^{-1}\ (10^{-8})$ in the upper 30 cm of the topsoil (Figure 5). The susceptibility then gradually increases through upper part of the Popcorn Unit until it actually peaks at a X_{LF} value of 69.5 $m^3\ kg^{-1}\ (10^{-8})$ and a X_{HF} value of 68.4 $m^3\ kg^{-1}\ (10^{-8})$ at 45 cm below the surface (bs). This increase suggests the possibility of a stable surface where weathering has enhanced the magnetic susceptibility in this portion of the profile. The susceptibility values decline to approximately 39 $m^3\ kg^{-1}\ (10^{-8})$ at a depth of 85 cm bs. The decline is near the stratigraphic division of the Popcorn Unit and the underlying Gray Unit and may relate to the soil formation processes associated with the two strata. The susceptibility values increase in the Gray Unit until they reach a maximum X_{LF} value of 83.9 $m^3\ kg^{-1}\ (10^{-8})$ and X_{HF} value of 82.6 $m^3\ kg^{-1}\ (10^{-8})$ at 1.25 m bs. This increase also suggests the possibility of a stable surface where weathering has enhanced the magnetic susceptibility in this portion of the profile. The susceptibility values then drop to a X_{LF} value of 54.4 $m^3\ kg^{-1}\ (10^{-8})$ and a X_{HF} value of 53.5 $m^3\ kg^{-1}\ (10^{-8})$ at 1.55 m bs. There is a sharp rise in values at 1.65 m bs to approximately 73 $m^3\ kg^{-1}\ (10^{-8})$ and then a substantial drop to approximately 40 $m^3\ kg^{-1}\ (10^{-8})$ at 1.7 m bs where the values stabilize to the base of the susceptibility column approximately 35 cm above the base of the backhoe excavation. The X_{LF} values range from 39.2 $m^3\ kg^{-1}\ (10^{-8})$ to 83.9 $m^3\ kg^{-1}\ (10^{-8})$ with a mean of 62.55 $m^3\ kg^{-1}\ (10^{-8})$ and a standard deviation of 12.1 $m^3\ kg^{-1}\ (10^{-8})$. The X_{HF} values range from 38.4 $m^3\ kg^{-1}\ (10^{-8})$ to 82.6 $m^3\ kg^{-1}\ (10^{-8})$ with a mean of 61.51 $m^3\ kg^{-1}\ (10^{-8})$ and a standard deviation of 11.97 $m^3\ kg^{-1}\ (10^{-8})$.

Results of the Frequency Dependency Susceptibility

Frequency dependency susceptibility measurements are useful in detecting the presence of ultrafine (<0.03μm) superparamagnetic ferrimagnetic minerals resulting from bacterial or chemical processes in the soil (Dearing 1994:17-18). The concentration of superparamagnetic grains provides information on the origins of magnetite and domain size in primary and secondary minerals associated with environmental magnetism studies. Primary minerals (e.g., ferrimagnetic iron oxides and sulphides such as magnetite, maghemite, titanomagnetite, titanomaghemite, etc.) are minerals formed in igneous rocks and contain an extremely high percentage of their original magnetic properties. Secondary minerals (e.g., other ferrimagnetic iron oxides and sulphides) represent minerals formed by processes associated with burning, fossil fuel combustion, diagenesis, authigenesis, soil formation, and bacteria (Dearing 1994:42). Domain state and crystal size give clues to the formation processes of magnetite. These tend to fall into three categories. The multidomain size category contains primary rock minerals and products of fossil fuel combustion. Stable single domain size ranges contain primary rock minerals and secondary minerals formed by fossil fuel combustion, burning, pedogenesis, and bacteria. Burning, pedogenesis, and bacteria produce superparamagnetic behavior in the mineral domain (Dearing 1994:42).

Samples with superparamagnetic ferrimagnetic minerals typically show as slightly lower values when measured in the high frequency range compared to their low frequency measurements. With low $X_{fd\%}$ values of less than 2% virtually no superparamagnetic grains (< 10%) are present in the sample (Dearing 1994:43). $X_{fd\%}$ values of 2% to 10% indicate that samples consists of an admixture of less than approximately 10% superparamagnetic grains with other coarser stable single domain size and multidomain size ferrimagnetic iron oxides and sulphides. A $X_{fd\%}$ value of 8% is equivalent to a superparamagnetic grain concentration of 50%. Samples with $X_{fd\%}$ values of 10% contain virtually all superparamagnetic domain sized grains, greater than 75%. Very high $X_{fd\%}$ values greater than 12% to 14% are extremely rare, and may indicate an erroneous measurement, metal contamination, anisotrophy, or a weak sample (Dearing 1994:43). This simple mixing model provides an estimate of the contribution of the sample's magnetite by superparamagnetic grains.

XU2

The $X_{fd\%}$ values decrease in the upper 60 cm of the profile from 2.26% to 1.04% (Figure 6). The $X_{fd\%}$ values then increase to 1.67% at 70 cm bs. The $X_{fd\%}$ values decrease to 0.24% at 1.00 m bs. At 1.15 m bs, the $X_{fd\%}$ value has increased to 1.41%. From there the $X_{fd\%}$ value drops to 0.99% at the base of the sample column. This implies that the changes in the X^{lf} values in the profile resulted from increased weathering of the stable ground surface or in the deposition of magnetic enriched sediments. The $X_{fd\%}$ values ranged from 0.24% to 2.26% with a mean of 1.158% and a standard deviation of 0.4388%.

Trench 1A

The $X_{fd\%}$ values decrease in the upper 40 cm of the profile from 2.11% to 0.99% (Figure 6). The $X_{fd\%}$ values then increase to 2.14% at 55 cm bs. The $X_{fd\%}$ values fluctuate

between 1.44% and 2.30% from 55 cm bs to 1.25 m bs. The $X_{fd\%}$ values drop to –1.78% at 1.30 m bs and then increase sharply to 3.73% at 1.35 m bs. This appears to correlate with the slight increase in the X^{lf} values noted at the same level below the surface. At 1.40 m bs, the $X_{fd\%}$ value has decreased to 1.39%. From there to the bottom of the sample column at 1.745 m bs, the X^{lf} values increase to 2.21%. Although most of the X^{lf} values are below 2% throughout the profile, the increases over 2% suggest some modification to the primary minerals and the formation of secondary minerals. The lower $X_{fd\%}$ values suggest that main cause for changes in the X^{lf} values are from increased weathering of the stable ground surface or in the deposition of magnetic enriched sediments. The higher $X_{fd\%}$ values imply other causal factors especially at 1.35 m bs, which may include human activities. The $X_{fd\%}$ values ranged from –1.78% to 3.73% with a mean of 1.695% and a standard deviation of 0.7756%.

Conclusions

During the summer of 2001, archeologists and volunteers from PaleoCultural Research Group, New Mexico State University, Fort Carson, and the National Park Service conducted excavations at the Barnes Folsom Site (5LA9187). The excavations were conducted as part of the Army's research into the Paleoindian occupation of the Pinon Canyon Maneuver Site in Las Animas County, Colorado. Magnetic susceptibility samples were collected from two locations: the backhoe Trench 1A and XU2. Low frequency and high frequency responses were measured with a Bartington MS2 magnetic susceptibility system. The frequency dependency was also computed.

Increases in X^{lf} values through magnetic enhancement provide information on the accumulation of ferrimagnetic minerals in the soil through numerous mechanisms as indicated above. In analyzing the magnetic susceptibility data from the Barnes Folsom Site, one needs to consider all of these factors. XU2 has a substantial increase in the X^{lf} values at 30 cm bs and minor fluctuations at 70 cm bs, 90 cm bs, and 1.10 m bs. The upper portion of the susceptibility profile is one that closely resembles a typical soil with magnetic enhancement in the topsoil. The increase in magnetic enhancement at 90 cm bs correlated to the unconformity between the light carbonate and the dense carbonate strata in the Gray Unit. The increase at 1.10 m bs may be the result of a relatively stable surface. Trench 1A has increases in the magnetic enhancement at 45 cm bs, 1.25 m bs, and at 1.35 m bs. All three locations have magnetic enhancements that suggest the presence of a stable surface layer during the accumulation of sediments in this profile.

The data resulting from the frequency dependent susceptibility provides a view of the types of magnetic material, which is found in the soils from the five excavation units. The results indicate the types of ferrimagnetic minerals and give a clue as to their formation: primary minerals versus secondary minerals. The measurements at the two frequencies (X_{LF} and X_{HF}) are used to detect the presence of ultrafine (<0.03 μm) superparamagnetic ferrimagnetic minerals. The results are recorded as a percentage of the original LF value. These minerals occur as crystals, which resulted from bacteria or chemical processes in the soil (Dearing 1994:17). Slightly lower values are obtained in the high frequency measurement (HF) throughout all of the profiles of XU2 and Trench 1A except in the magnetostratigraphic profile of Trench 1A at a depth of 1.30 m bs. Although the LF and HF values are high (78.6 and 80.0, respectively), the

frequency dependency percentage is negative. The frequency dependent data from the profiles of the two magnetic susceptibility sample columns indicated the presence of the ultrafine minerals in the soils from the units. Values over 2% suggest a combination of the three types of domain sizes which suggest multiple causes for the magnetic enhancement found in the excavation units. Values under 2% suggest that the magnetic enhancement relates to the presence of primary minerals which is controlled by weathering, erosional, and depositional processes at the site. When combined with unit stratigraphic profiles, artifact analysis, geoarcheological analysis, the magnetic susceptibility data provide complementary data that can elucidate our understanding of the environmental history and site formation processes at the site, as well as, human activities.

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Table 1. Magnetic Susceptibility Samples from XU2.

elevation (m)	total weight of packed container (g)	corrected LF susceptibility	corrected HF susceptibility	frequency dependent susceptibility %
999.855-999.80	11.8	93.1	91.0	2.26
999.80-999.75	11.4	92.5	90.8	1.84
999.75-999.70	11.7	98.5	97.1	1.42
999.70-999.65	11.8	99.9	98.4	1.50
999.65-999.60	11.5	110.5	109.2	1.18
999.60-999.55	11.9	112.9	111.3	1.42
999.55-999.50	12.0	108.4	107.2	1.11
999.50-999.45	11.7	100.6	99.3	1.29
999.45-999.40	11.9	86.5	85.5	1.16
999.40-999.35	11.8	63.3	62.6	1.11
999.35-999.30	11.6	54.9	54.2	1.28
999.30-999.25	11.5	48.1	47.6	1.04
999.25-999.20	12.0	43.4	42.8	1.38
999.20-999.15	12.3	48.0	47.2	1.67
999.15-999.10	12.0	44.9	44.4	1.11
999.10-999.05	12.2	43.4	43.0	0.92
999.05-999.00	12.6	43.1	42.8	0.70
999.00-998.95	12.4	49.8	49.5	0.60
998.95-998.90	12.5	35.4	35.1	0.85
998.90-998.85	12.1	41.4	41.3	0.24
998.85-998.80	12.2	50.7	50.4	0.59
998.80-998.75	12.3	56.3	55.9	0.71
998.75-998.70	12.3	49.6	48.9	1.41
998.70-998.65	13.2	40.5	40.1	0.99

Sensor : MS2B
Units : SI (m^3 kg^{-1}) x 10^{-8}
Range : x0.1

Container weight : 3.0 g (Mass specific)
Container susceptibility (sus): -0.4 (SI units)

Table 2. Magnetic Susceptibility Samples from Trench 1A.

elevation (m)	total weight of packed container	corrected LF susceptibility	corrected HF susceptibility	frequency dependent susceptibility %
1000.095-1000.05	11.1	78.4	76.8	2.04
1000.05-1000.00	11.2	75.7	74.1	2.11
1000.00-999.95	11.4	66.0	65.0	1.52
999.95-999.90	11.5	55.6	54.8	1.44
999.90-999.85	11.7	51.6	50.8	1.55
999.85-999.80	11.9	49.4	48.8	1.21
999.80-999.75	12.0	54.6	53.8	1.47
999.75-999.70	11.4	60.7	60.1	0.99
999.70-999.65	12.2	69.5	68.4	1.58
999.65-999.60	12.4	61.8	61.1	1.13
999.60-999.55	12.0	60.7	59.4	2.14
999.55-999.50	11.9	60.1	59.1	1.66
999.50-999.45	12.2	61.5	60.3	1.95
999.45-999.40	12.2	54.8	53.8	1.82
999.40-999.35	12.5	54.3	53.6	1.29
999.35-999.30	12.4	43.8	43.1	1.60
999.30-999.25	12.0	39.2	38.4	2.04
999.25-999.20	12.5	60.2	58.9	2.16
999.20-999.15	12.1	63.1	62.0	1.74
999.15-999.10	12.3	66.2	64.9	1.96
999.10-999.05	12.6	64.3	62.9	2.18
999.05-999.00	12.1	65.1	63.6	2.30
999.00-998.95	12.1	65.6	64.6	1.52
998.95-998.90	11.8	83.6	82.4	1.44
998.90-998.85	12.0	83.9	82.6	1.55
998.85-998.80	12.2	78.6	80.0	-1.78
998.80-998.75	12.2	80.5	77.5	3.73
998.75-998.70	12.0	79.1	78.0	1.39
998.70-998.65	12.0	71.2	70.0	1.69
998.65-998.60	11.9	63.0	62.0	1.59
998.60-998.55	12.5	54.4	53.3	2.02
998.55-998.50	12.6	58.1	57.1	1.72
998.50-998.45	12.0	73.8	72.4	1.90
998.45-998.40	12.2	40.3	39.3	2.48
998.40-998.35	12.1	40.7	39.8	2.21

Sensor : MS2B
Units : SI ($m^3 kg^{-1}$) x 10^{-8}
Range : x0.1

Container weight : 3.0 g (Mass specific)
Container sus : -.40 (SI units)

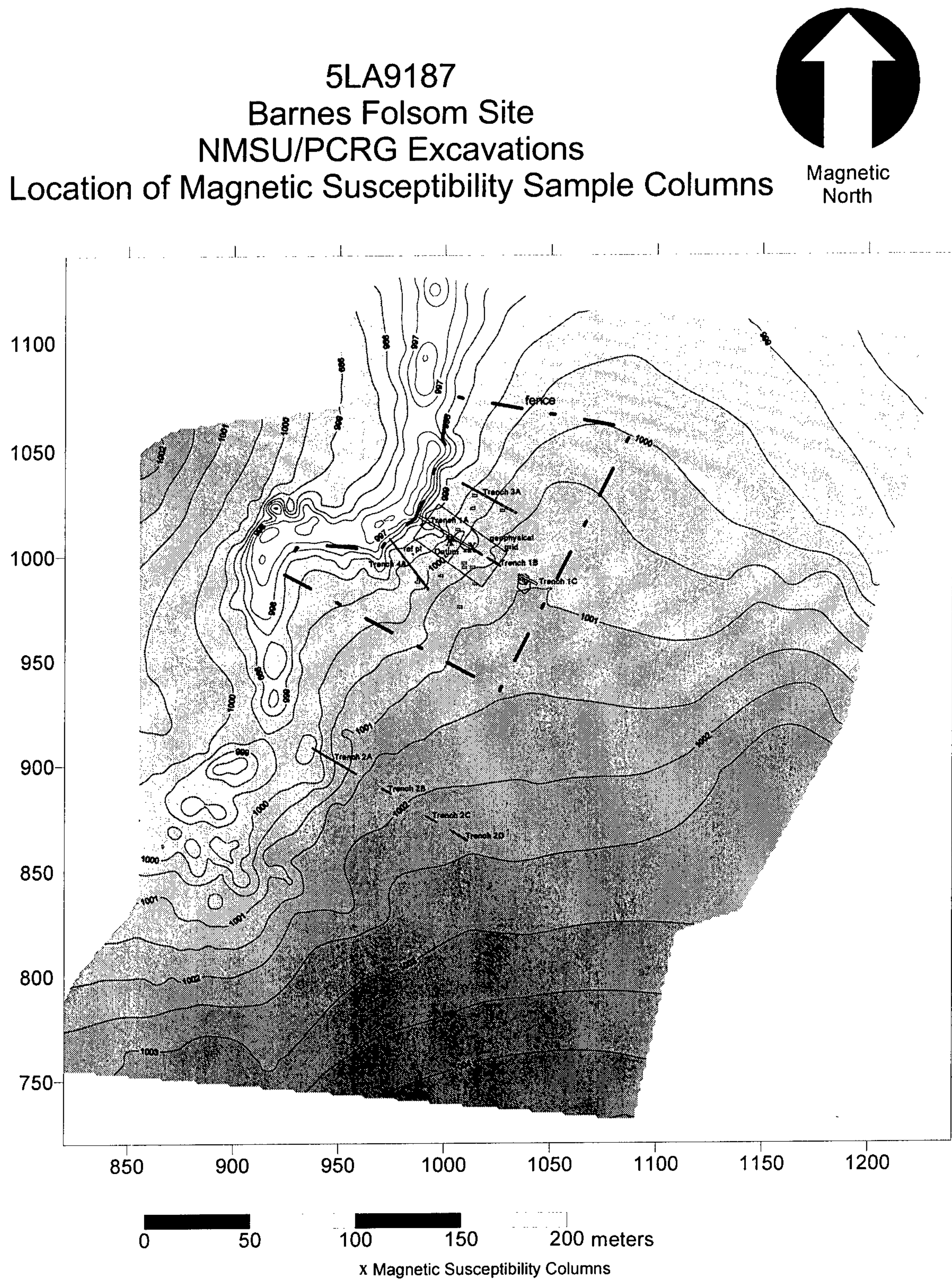

Figure 1. Location of Magnetic Susceptibility Sample Columns at 5LA9187.

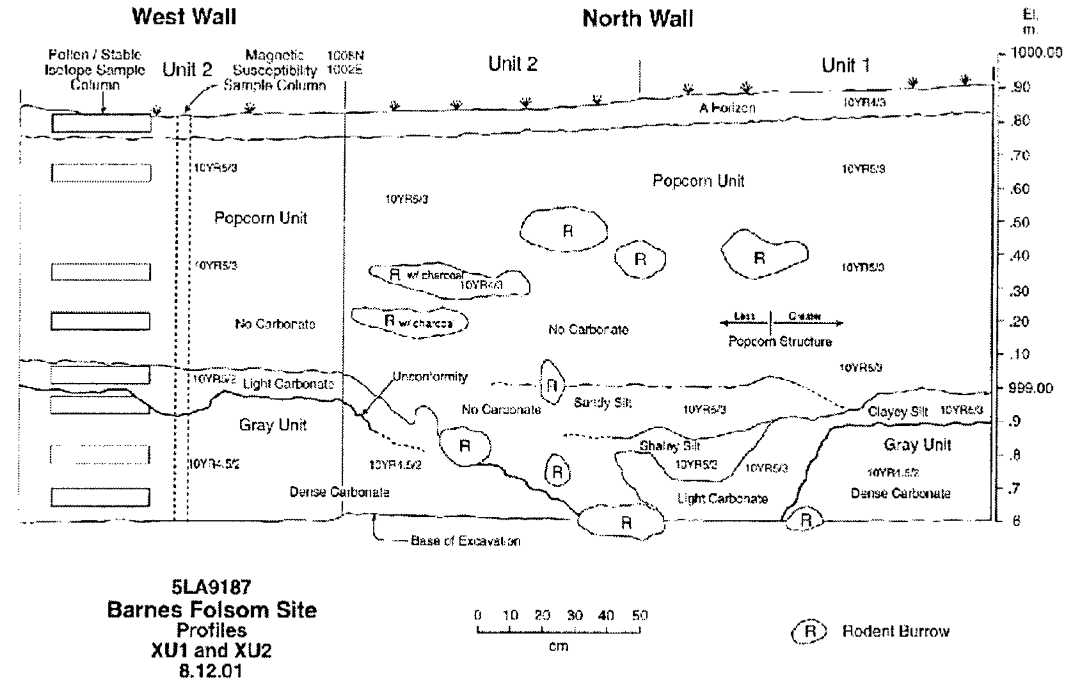

Figure 2. Geoarcheological stratigraphic profiles of north and west walls of XU2.

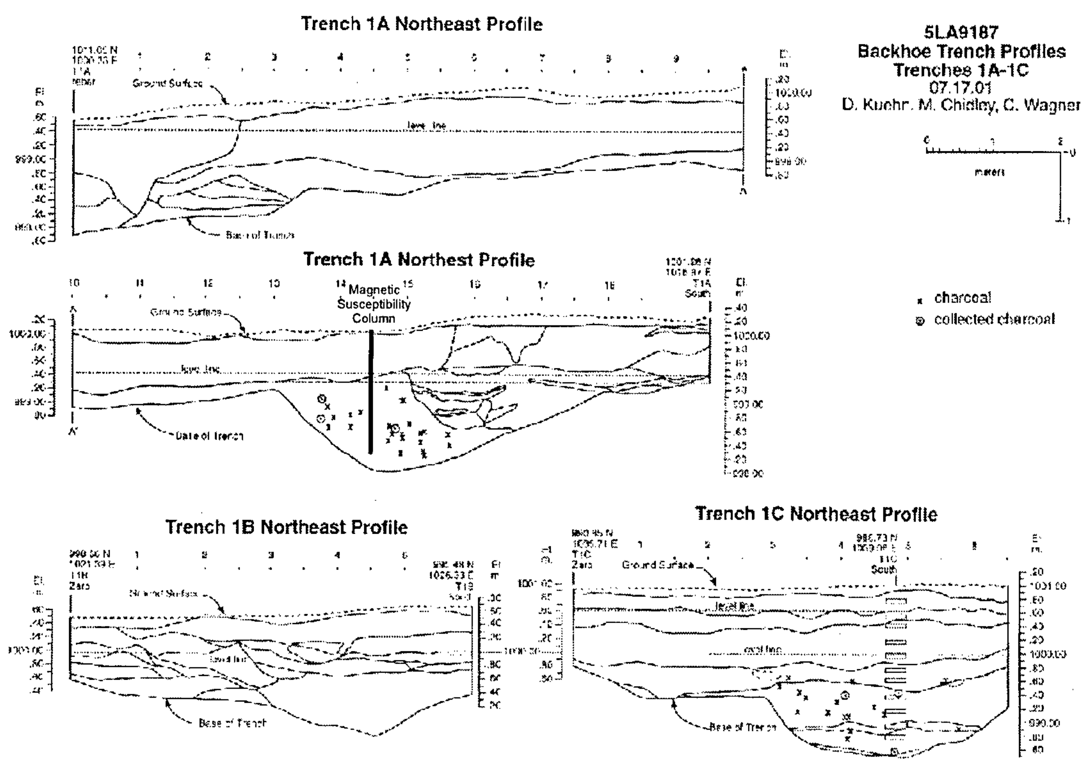

Figure 3. Geoarcheological stratigraphic profiles from Trench 1A.

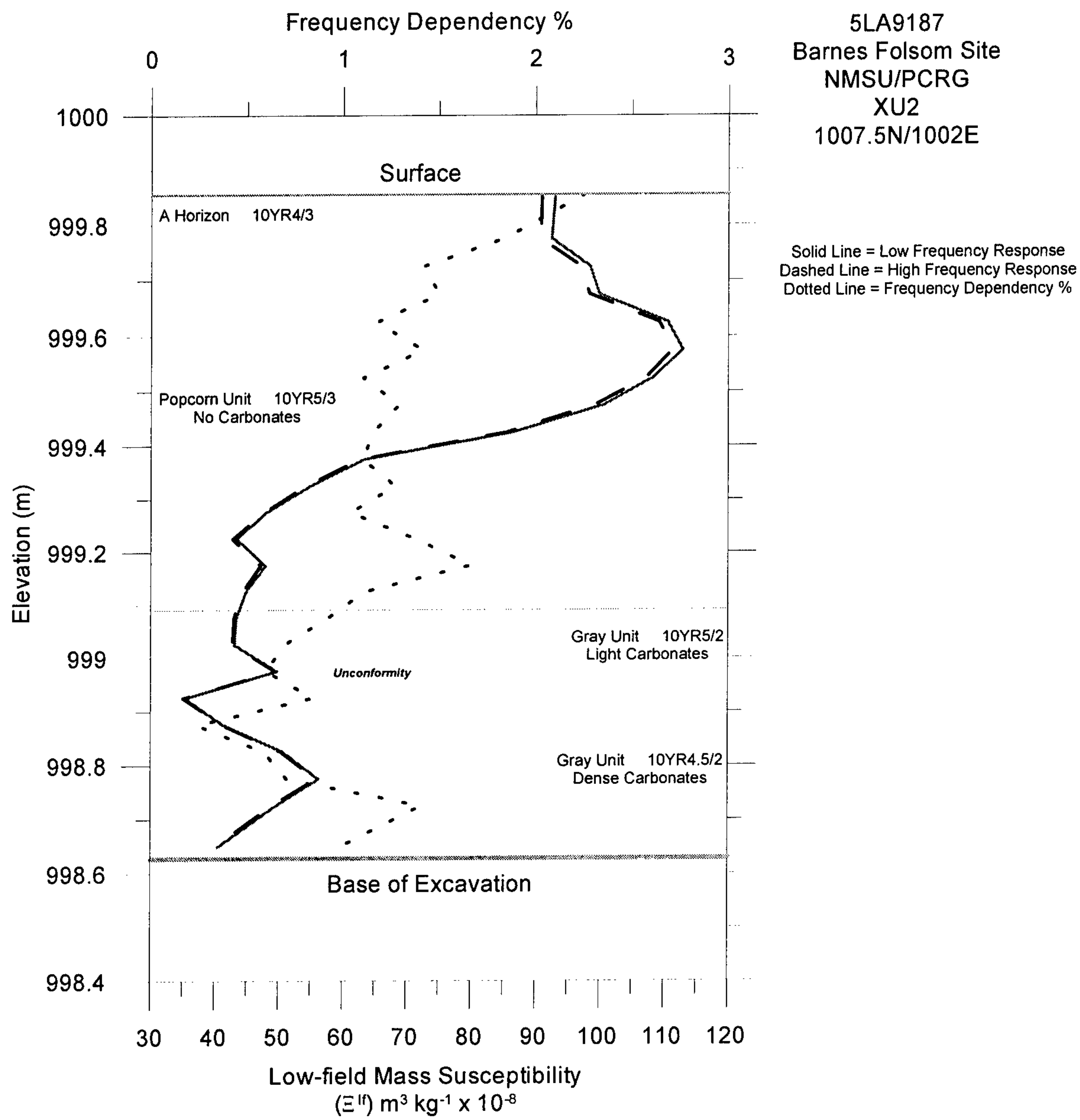

Figure 4. Magnetostratigraphic profile from XU2.

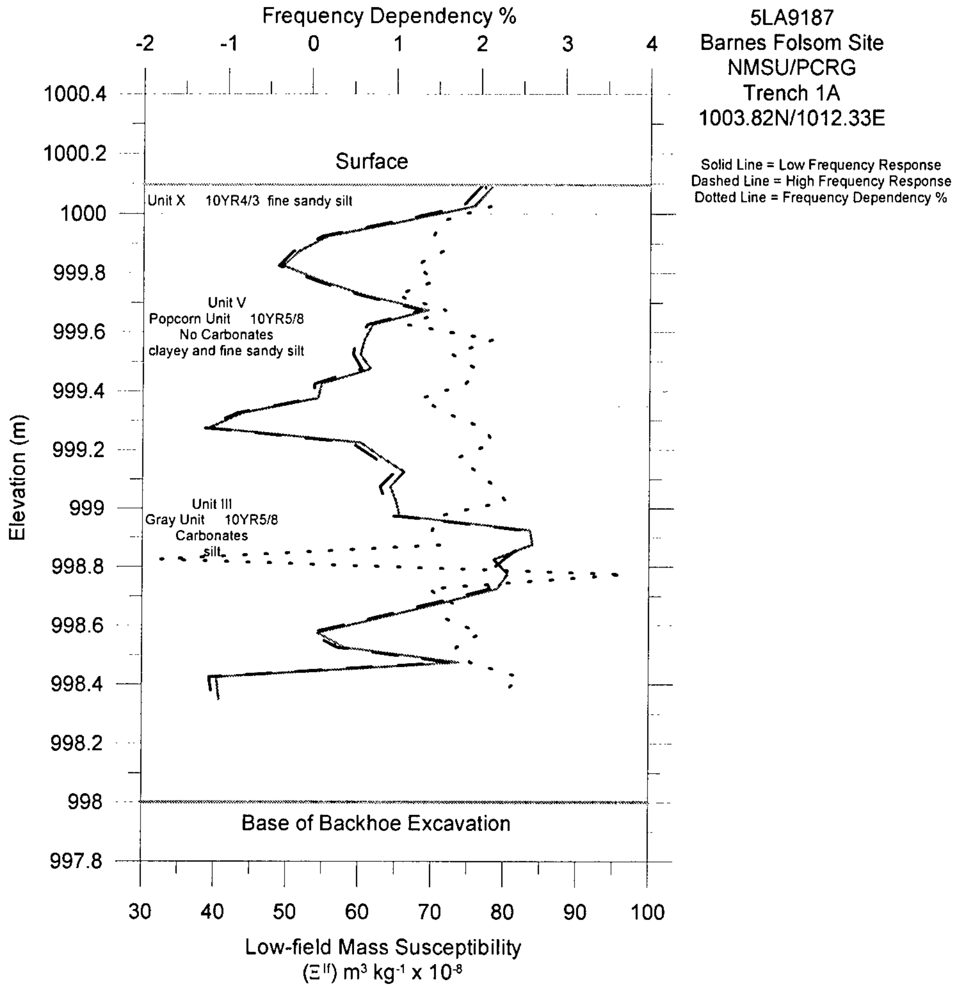

Figure 5. Magnetostratigraphic profile from Trench 1A.

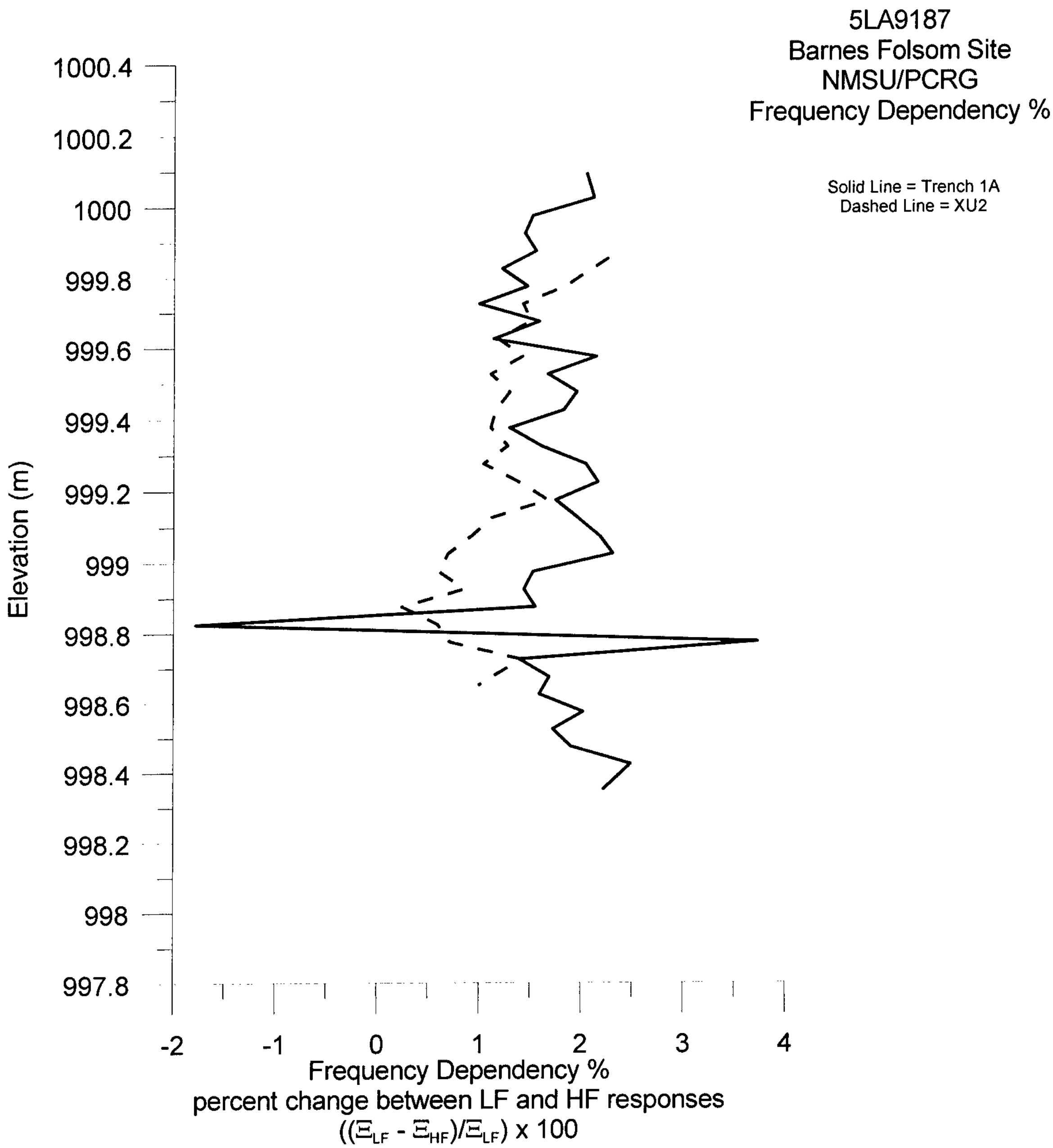

Figure 6. Frequency dependency percentages of the two magnetic susceptibility profiles.

APPENDIX C. ARCHAEOMAGNETIC LABORATORY REPORT

Jeffrey L. Eighmy

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Department of Anthropology
Archaeometric Laboratory
Fort Collins, Colorado 80523

January 8, 2002

Mr. Randy Korgel
DECAM
Building 302
801 Tevis Street
Ft. Carson, CO 80913-4000

Dear Randy:

Enclosed please find the archaeomagnetic lab report for the sample that I collected from Feature 10 at 5LA9187 in the Piñon Canyon Maneuver area. As you know this will not be a normal archaeomagnetic report since the burned feature is far older than any existing master curve and cannot be dated. The sample can not be dated archaeomagnetically because we simply don't have enough control samples to construct accurate master curves prior to AD 600. Control samples are important because determining an archaeomagnetic date consists of comparing the magnetic direction stored in a burned feature to a set of control samples (a set of independently dated pole positions). The sample "dates" to the age of the samples with similar directions. Although we cannot date this sample, it will be able to add it to our set of control samples (see below) for the early part of the 6th millennium BC.

Therefore, this letter consists mainly of a report of a pole position, but this pole position is still important. It is an important contribution because we can include it as part of the control set of independently dated pole positions. Thanks to the radiocarbon dates that you and Ahler collected, the sample from 5LA9187 will contribute to the database of independently dated archaeomagnetic pole positions. Blinman and Cox (1996; Cox and Blinman 1996:19.1-19.56) have collected a number of other early positions, but, apparently, none of these is as early as the Feature 10 sample from 5LA9187.

Cox, J.R. and E. Blinman
1996 NSEP Archaeomagnetic Dating: Procedures, Results, and Interpretations. In *Pipeline Archaeology 1990-1993: The El Paso Natural Gas North System Expansion Project, New Mexico and Arizona*, Volume 12, edited by T.M. Kerns. Farmington, NM: Western Cultural Resources Management, Inc., pp. 19.1-19.56.

Blinman, E. and J.R. Cox
1996 Archaeomagnetic Dating Potential at the Piñon Canyon Maneuver Site, Fort Carson, Colorado. Contract Report prepared for the National Park Service, Rocky Mountain Regional Office, Denver, CO. Archaeomagnetic Dating Laboratory. Museum of New Mexico, Office of Archaeological Studies, Sante Fe, NM.

Feature 10, 5LA9187 - An Important Data Point

First of all, the feature produced a good pole position. This result alone is significant because open camping hearths on the Plains often do not retain good magnetic directions (Eighmy, Taylor and [illegible] 1993). We are fortunate with this sample because, in the field, it appeared to be only lightly burned in two small (about 10 cm) areas. From these two small areas I collected 9 specimens. The magnetic directions of seven of these specimens clustered well, and the mean of the directions indicated a paleopole location of 7[illegible]° North Latitude and 88.87° West Longitude. What this mean direction

and location tells us that the geomagnetic field around the hearth indicate a magnetic pole in the 72°N/89°E region at the time the feature was fired.

Eighmy, J.L., RS. Klein, and P.Y. Klein
1993 Archaeomagntic Dating on the Great Plains. *Plains Anthropologist* 38:21-50.

Fortunately, we have a good idea when the feature was fired, and, thus, we can fix the age to this geomagnetic field orientation. You and Stan Ahler collected three radiocarbon dates from Feature 10 that give us a good idea of the feature's age. Stan reported to me the following radiocarbon dates, and I converted them to calibrated calendar dates and averaged them.

Beta-158491	6800±40	5737-5625 BC	
ETH-24872	6992±64	5988-5732 BC	
Eth-24873	6906±68	5975-5662 BC	[redacted]
	Calibrated average	**5837-5665 BC**	

I judge this average to be a very good fix on the age of the 72°N/89°E pole position. Therefore, even though I cannot report an archaeomagnetic date for the bum, the collection was an extremely important opportunity for me and for archaeomagnetic analysis, in general, to begin the arduous task of collecting hundred of similar pole positions with the eventual goal of tracking the prehistory of the earth's magnetic field into earlier and earlier time periods.

I appreciate the opportunity to collect this feature and determine this pole position.

I will be happy to modify and/or expand on this report if necessary for your publication purposes.

Sincerely,

Jeffrey L. Eighmy

Director

[redacted]

Xc Stan Ahler, PCRG, P.O. Box [illegible], Flagstaff, AZ 86002
Jack Hofman, Departmen[illegible] of Anthro, University of Kansas, Lawrence, KS 66045

ARCHAEOMETRIC LABORATORY REPORT

Archaeometric Laboratory
Department or Anthropology
Colorado State University
Ft. Collins, Colorado 80523
(970) 491-7762 or 491-5784

Sample ID:	5LA9187-1	**Feature ID:**	Feature 10; unit 30
Site Latitude:	37.52° N	**Site Longitude:**	256.07°E
Site Declination:	9.47°	**Expected Date:**	
Collector:	Eighmy	**Date Collected:**	8-23-01

Laboratory Analysis

Demagnetization Steps (mT)	NRM	5.0	10.0	15.0
α_{95} (°)	3.18	7.86	5.31	7.75
Precision Parameter – k	362.43	60.00	130.06	61.61
Inclination (dip°)	70.20	62.66	63.49	61.64
Declination (E°)	7.70	359.05	355.43	353.19
Mean Sample Intensity (E-07 Tesla)	.40	.47	.38	.28
No. Specimens Collected/ No. Specimens Used	9/7	9/7	9/7	9/7
Specimen # of Outlier(s)	#2, 5	#2, 5	#2, 5	#2, 5

Final Processing Results

Demagnetization Level Used	NRM
Paleolatitude (N°)	72.46
Paleolongitude (E°)	271.13
Error Along the Great Circle – EP (°)	4.72
Error Perpendicular to the Great Circle – EM (°)	5.50

Signed: [signature] Date: /6/02